CHAPTER TWO

ALTERNATIVES, INCLUDING THE PROPOSED ACTION

INTRODUCTION

The National Environmental Policy Act (NEPA) requires analysis of a proposed action and other reasonable alternatives, including no action. The no action alternative provides a baseline for estimating environmental effects. Five alternatives for the Diamond Lake Restoration Project are considered in detail. The action alternatives were developed following intensive field investigations and research in response to the issues identified. Alternatives considered, but eliminated from detailed study are also documented in this chapter.

The agency has identified Alternative 5 as the preferred alternative for this Final Environmental Impact Statement.

CHANGES BETWEEN DRAFT AND FINAL

For Chapter 2, in response to comments on the DEIS, a fifth alternative has been added to the FEIS and Alternative 4 has been modified to include recommended improvements. In order to accommodate changes in Alternative 4, the project lifetime has been changed from six to seven years for all action alternatives. Appendix BB and CC have been incorporated into the FEIS and include requested additional details on monitoring, contingency plans, and activities designed to reduce tui chub reintroduction potential. Requested additional details on fish carcass emulsification, the proposed rotenone treatment, and timing of fish stocking related to zooplankton recovery have been included. Two maps have been added as requested. Corrections and additions have been made to the Best Management Practices section. Summary tables have been updated to include the addition of Alternative 5 and modification of Alternative 4. A minor correction was made to the description of the required non-significant Forest Plan amendment.

ALTERNATIVES CONSIDERED IN DETAIL

The alternatives considered in detail are as follows:

Alternative 1 (No Action)

This alternative serves as the baseline for estimating environmental effects of the action alternatives. No canal reconstruction, lake draw down, mechanical fish harvest, chemical treatment, fish carcass removal, or lake refill would occur. No active measures to improve water quality at Diamond Lake would be implemented. Potentially harmful algae blooms and lake closures would be expected to continue.

ODFW would continue with the existing experimental fish stocking program (100,000 fish) in 2004 and 2005. In 2006, ODFW and the Oregon Fish and Wildlife Commission (OFWC) would revisit the Diamond Lake Fishery Management Plan to determine appropriate stocking. Based on current knowledge and budget, it is expected that ODFW would stock Diamond Lake with 24,000 legal sized rainbow trout on annual basis in 2006 and beyond.

Alternative 2 (Proposed Action)

The Umpqua National Forest, in cooperation with multiple state and federal agencies, proposes to implement a series of actions that would meet the need for improvement of water quality and the recreational fishery at Diamond Lake. Proposed activities include: canal reconstruction, a fall/winter lake draw down, mechanical fish removal and utilization, a September rotenone (fish toxicant) treatment to eradicate tui chub, fish carcass removal and utilization, water management during lake refill period, monitoring, fish restocking, educational activities, and contingency measures for controlling tui chub if they are reintroduced to Diamond Lake in the future.

Alternative 2 would include a non-significant amendment to the 1990 Umpqua National Forest Land and Resource Management Plan (LRMP). The amendment would allow the use of rotenone within Diamond Lake, Short and Silent Creeks, which would not normally occur under Standard and Guidelines Fisheries #6 (LRMP IV-33), Water Quality/Riparian Areas #8 (LRMP IV-60) and Prescription C2-1 (LRMP 169-171). The non-significant Forest Plan Amendment (Amendment #5) would apply to this project only; upon completion of the project, Standard and Guidelines, Fisheries #6 (LRMP IV-33), Water Quality/Riparian Areas #8 and Prescription C2-I would again apply to Diamond Lake, Short and Silent Creeks.

Primary responsibilities for lead and cooperating agencies are documented below. Additional information describing responsibilities of all partnering agencies is provided in Appendix A.

> The Forest Service would: 1) authorize and assist in implementation of canal reconstruction, lake draw down, fish carcass removal and processing, education, and monitoring (in compliance with the Clean Water Act and LRMP MA-2 goals); 2) issue a permit for the application of rotenone (FSM 2151.04a, FSH 2109.14); and 3) potentially modify a special use permit to allow the Diamond Lake Resort to conduct requested dock clean up activities detailed below (Term Special Use Permit March 14,1915 as amended July 28, 1956 or the act of March 30,1948, Ref. FSM 2710).
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> ODFW would: 1) be responsible for all aspects of rotenone application (ORS 506.109 (subsection 2) and ORS 506.119); 2) pursue approval for the proposed fish stocking strategy through the Oregon Fish and Wildlife Commission (OFWC) and the appropriate public process (ORS 496.012); and 3) assist in implementation of canal reconstruction, lake draw down, fish carcass removal and processing, education, and monitoring.
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> ODEQ would: 1) process appropriate water quality permits, certifications, or other appropriate venues necessary for implementation of the lake draw down and rotenone application (under authority of Oregon Revised Statutes, 468B); and 2) assist in

implementation of canal reconstruction, lake draw down, fish carcass removal and processing, education, and monitoring.

Proposed activities are described in detail below in the order in which they would be implemented:

Canal Reconstruction: There is an existing earthen canal (ditch) in the northwest corner of Diamond Lake adjacent to Lake Creek. In its original condition, this canal was used to lower Diamond Lake prior to the rotenone treatment that occurred in 1954. The canal extends approximately 900 feet from the lakeshore southward into Diamond Lake. The canal is interrupted or filled in at the Dellenback Bike Trail and US Forest Service Road 4795 crossings, but continues northward, parallel to Lake Creek for about 1,100 feet before it terminates next to Lake Creek. The canal has not been used since about 1954 and soil, debris, and aquatic plants have partially filled the canal, thereby reducing its flow capacity.

This project would reconfigure the existing canal to its original dimensions. From the lakeshore to the canal outlet into Lake Creek, the canal would be excavated to its original configuration. The reconstructed canal would be a native surface (soil and bedrock) channel with a headgate structure to control flow of water from the lake. Specific actions necessary to accomplish this would include: 1) removal of the fill from the bike trail and Road 4795 where they cross the canal, 2) removal of the existing headgate water control structure, 3) reshaping the canal to its original dimensions, 4) installing a new headgate water control structure, 5) extending or replacing (depending on its condition) the existing concrete box culvert under Forest Service Road 4795, 6) constructing a new box culvert under the bike trail and, 7) if necessary during construction, building temporary bridges or culverts to maintain access to the bike trail and summer cabins. Excavated material would be placed in an approved location where there is no risk of erosion. The headgate water control structure on Lake Creek would also be rebuilt or replaced.

From the lakeshore into the lake (to the original canal initiation point), the canal would be dredged to its original depth and configuration. Specific actions associated with this portion of the project would include: 1) Removal of material from the existing canal using a floating suction dredge or other appropriate equipment, and 2) Utilizing the dredge spoils to expand an existing wetland located within the northwest corner of the lake. Dredge spoils (approximately 900 cubic yards) would be pumped into an area within the lake immediately adjacent to an existing wetland. The area would be fenced off using silt fence. This fence would keep the dredge spoils in place until wetland vegetation colonizes and stabilizes the site. Following this, the fence would be removed. The expanded area would be approximately 0.6 acres in size.

Fall/Winter Lake Draw Down: Using both the reconstructed canal and Lake Creek for water transport, this project would lower the water level in Diamond Lake by eight feet from its normal summer level[1]. The lake draw down would begin on or around September 15th in the year prior to chemical treatment. A gravity-driven draw down would occur at a discharge

[1] Normal summer water level refers to the midsummer maximum pool level (about 68,100 acre-feet) with boards regulating water flow from Diamond Lake into Lake Creek. ODFW has existing water rights that allow them to raise the water level in Diamond Lake by placing wooden boards across the Lake Creek outlet.

rate approximating a bankfull[2] flow in Lake Creek (roughly 110 cubic feet per second). The total volume of water removed from the lake would be approximately 24,000 acre-feet[3].

The draw down would be accomplished as follows: 1) At the beginning of the draw down, over a period of seven days, flows within Lake Creek would be gradually increased to a bankfull flow level, 2) Once a bankfull flow is achieved, this flow level would be maintained until the lake level reached the desired eight foot reduction, and 3) Only naturally induced storm flows (from large rain events) would be allowed to exceed the bankfull flow. The speed at which the lake drains is highly dependant upon the weather patterns for that given year. Therefore, predicting the exact date when the draw down would be complete is not feasible. However, the target date for achieving the eight foot draw down is April 1st in the year of treatment. Once the desired level is achieved, it would be maintained throughout the summer and fall of that year.

This lake draw down would accomplish multiple objectives:

- The draw down would temporarily de-water the marshes at Silent Creek and the northwest end of the lake, leaving only open water to be chemically treated, thereby increasing the likelihood of a complete fish kill.
- The draw down would concentrate the fish population and reduce the total amount of rotenone needed.
- The draw down would temporarily dry up the Lake Creek outlet, preventing rotenone treated waters from flowing downstream into the North Umpqua River subbasin.
- Timing the draw down in the fall and winter months would minimize potential downstream nutrient and other water quality affects associated with transporting additional lake water through the system.
- Designing the draw down to occur in the fall and winter months would allow for the lake to be lowered by the desired eight feet prior to the onset of higher spring snowmelt flows. During spring snowmelt, runoff would flow out the canal and into Lake Creek under the naturally occurring flow regime.

PacifiCorp would be notified in advance of canal opening and closure and would adjust their water schedules accordingly. Temporary docks or boat ramp extensions (described in detail in the rotenone treatment section) would be installed to facilitate boat access to the lake following the draw down. Because the draw down would make travel onto the partially frozen ice on Diamond Lake a winter safety hazard, public travel on the ice during this time period would be prohibited.

Mechanical Fish Removal and Utilization: Several methods[4] would be used to reduce fish biomass in Diamond Lake prior to a chemical treatment:

[2] In general terms, the bankfull stage refers to the stream flow that just fills the channel to the top of its banks and at a point where the water begins to overflow onto a floodplain (Rosgen 1996).
[3] An acre-foot is equivalent to a volume of water 1 foot deep over 1 acre of land (Viessman and Lewis 1996).
[4] A variety of tools/techniques would be used during prerotenone mechanical fish removal. Data regarding which techniques were considered most effective would be collected and recorded for use in other or future tui chub removal efforts.

- During the year of a chemical treatment, the Oregon Department of Fish and Wildlife (ODFW) would not stock Diamond Lake and would liberalize catch limits on fishing.
- During the spring/summer prior to a chemical treatment, ODFW crews would use nets and seines to harvest fish from the lake.
- For approximately one to four weeks in the summer or early fall prior to a chemical treatment, professional commercial fishing operations would be used to harvest fish from the lake. Fish carcasses would be converted to an organic fish emulsion product on site (lake shore)[5] or trucked to an off-site plant for utilization as fertilizer.

The objective of live fish removal would be to reduce the quantity of fish biomass available for conversion into nutrients following a chemical treatment.[6] Recycling of fish as fertilizer would reduce waste and the necessity to utilize landfills.

September Rotenone Treatment: The powdered formulation of the fish toxicant rotenone (Pro-Noxfish®) would be applied to Diamond Lake in September when water temperature and chemistry reached conditions considered optimal for achieving a complete fish kill. Rotenone would be administered according to label instructions at the necessary amounts based on water volume, temperature, and chemistry in Diamond Lake at the time of application.

To determine the minimum appropriate rotenone concentration levels, prior to application, site-specific bioassay tests[7] would be conducted on tui chub utilizing rotenone from the stock to be used in lake treatment and water from Diamond Lake. However, in general, according to current recommended application rates, a minimum and maximum range of active rotenone concentration of 0.025 and 0.10 parts per million (ppm) would be needed to achieve the treatment goal (Finlayson et al. 2000).

For example, based on a predicted water volume of 44,000 acre-feet following the draw down, mean temperature and pH observed in Diamond Lake in September, and an active rotenone concentration of 0.1 ppm[8], it is estimated that about 238,000 pounds of rotenone would be needed to eradicate the tui chub population.

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[5] The following describes general information about the type of fish emulsification process that would be used if an onsite operation is considered the most effective way to accomplish carcass utilization. With Environmental Recovery Solutions, the onsite conversion process entails prebreaking of carcasses, blending with an organic enzyme, digestion using ambient heat, screening, and then stabilizing with a 0-53-0 fertilizer. The on site emulsification process consists of reduction and primary containment. Reduced carcasses are initially contained in large polyethylene containers and transported to an off-site facility for chemical "breaking" and final containment or "bottling". A properly aerated emulsification process using fresh mortalities should not cause an increase in flies and mosquitoes. Environmental Recovery Solution's process of emulsification uses the entire fish so there is no waste or fish refuse. The emulsification product would not be contaminated with rotenone; the temperature, light, oxygen, and alkalinity of the emulsification processes will rapidly degrade the unstable rotenone and eliminate its toxic effects.

[6] Although mechanical removal of fish carcasses following a rotenone treatment is proposed, it is expected that some fish would sink to the bottom and would not be retrieved ("sinkers"). These carcasses would contribute to nutrient loading in Diamond Lake. Removal of fish prior to treatment would reduce the number and biomass of potential "sinkers" and thus reduce potential nutrient loads.

[7] A bioassay is a common laboratory test used to determine toxic levels of substances for a given species (Royce 1984).

[8] This treatment concentration would be met by applying 2 ppm of the Pro-Noxfish rotenone formulation (Finlayson et al. 2000).

All of the following detailed plans would be completed according to recommendations and examples provided in the "Rotenone Use in Fisheries Management: Administrative and Technical Guidelines Manual" prior to project implementation: rotenone application plan, site safety plan, site security plan, and a spill contingency plan (Finlayson et al. 2000). However, in general, handling and application of rotenone would be accomplished as follows.

After September 1 in the year of treatment, rotenone would be transported by truck directly to the Diamond Lake site via State Highway 97. Rotenone would be stored at three operational sites: the north end dock facilities, Thielsen View Campground and Broken Arrow Campground. Security would be provided 24 hours/day at each site while rotenone is present on site. Rotenone would be stored in the delivery trucks. Although it is not proposed for use and there are no foreseeable spill situations that would require its use, enough potassium permanganate (rotenone neutralizer) to neutralize the largest container of rotenone would also be stored on site[9].

Temporary docks would be needed at all three operational sites to facilitate loading rotenone onto boats or barges. National Guard temporary bridge facilities or ribbon bridges[10] would be used as temporary docks, if available. If these structures are not available, then the existing boat ramps would be extended with gravel to allow the use of loading booms to move rotenone containers onto barges.

Certified pesticide applicators would be responsible for all phases of rotenone application. Outlets would be closed and locked using control gates so treated water would not escape down the reconstructed canal or Lake Creek. Diamond Lake would be closed to the public during rotenone application and reopened when safety concerns were eliminated. Application of rotenone to Diamond Lake proper would be conducted systematically from boats and/or barges using high-pressure pumps and emulsification techniques similar to those used in mixing fire retardant. Treatment of the lake would take one to three days.

Concurrently, due to the potential presence of tui chub in these areas, sections of the two major inlet streams to Diamond Lake, Silent Creek and Short Creek, would be treated with rotenone. The lake level would be drawn down prior to application and only sections of the streams located within the dewatered lake bed would be treated[11]. The liquid rotenone formulation Noxfish®[12] would be used at an active

[9]Neutralizing agents are commonly transported and stored with rotenone as a precautionary measure in case rotenone is spilled or otherwise escapes into non-target water bodies. Use of potassium permanganate is not proposed under this alternative and it is not considered reasonable to assume that it would be used in association with the project. During the time period when rotenone would be stored and applied at Diamond Lake, headgates would be closed on the canal and Lake Creek, and the first 5.5 miles of Lake Creek would be dry. Rotenone treated waters would be confined within Diamond Lake. There are no foreseeable situations that would warrant neutralizing a spill in the project area because the available waters in proximity to storage sites would be scheduled for rotenone treatment and thus, a spill would not present a problem requiring neutralizer.

[10] Ribbon bridges are bridges created by placing sections of tread together on a floating pontoon.

[11] Estimated rotenone treatment distance for these creeks is 470 yards of Silent Creek and 550 yards of Short Creek.

[12] Finlayson et al. (2000) state that liquid rotenone is the only effective formulation of rotenone for treating flowing waters. Noxfish® is the recommended liquid rotenone product for use at Diamond Lake because it *does not* contain Piperonyl Butoxide, an additive in some liquid products that may persist in treated water for several months.

rotenone concentration level of about 0.10 ppm[13]. Rotenone would be applied at drip stations along the stream channels. Drip stations would be operated for approximately 17 days and would use approximately 375 gallons of liquid rotenone. Impassable barriers to upstream movement by tui chub would be constructed in these creeks and other smaller inlets during the lake draw down period. These barriers would prevent fish from escaping above the treatment area prior to and during the application of rotenone.

Diamond Lake outlets (Lake Creek and reconstructed canal) would remain closed until tests indicated that rotenone, rotenolone[14], and all semi-volatile and volatile organic compounds[15] associated with the chemical treatment had dissipated to non-detectable or trace levels in both the water column and lake bottom sediments (approximately one to two months).

Mechanical Fish Carcass Removal & Utilization: A commercial fishing or professional fish mortality recovery and recycling operation would be employed to collect fish carcasses as soon as logistically feasible following a chemical treatment of the lake. Harvested fish carcasses would be converted to an organic fish emulsion product through on-site processing and then trucked off-site, or carcasses would be trucked to an off-site plant for utilization as fertilizer.
Removal and utilization of fish carcasses would accomplish multiple objectives:

- A reduction in the level of nutrients (from decaying fish) that would be added to Diamond Lake and later transported downstream.
- A reduction in the negative aesthetic impacts (visual and odor) associated with large quantities of accumulated dead fish.
- A reduction in the waste and environmental impacts associated with disposal of large quantities of fish into a landfill.

Water Management During Lake Refill Period: As Diamond Lake begins refilling, the following water management strategy would be implemented to limit the length of time that Lake Creek is reduced to no or very low flows. When water in Diamond Lake becomes suitable for release (about November), canal headgates would be opened to allow approximately 10 cubic feet per second (cfs) of water to flow into Lake Creek and through the North Umpqua River system. The outlet would be periodically adjusted to maintain this flow as Diamond Lake refills with inflow exceeding the 10 cfs outflow. The rate of refill would depend largely on precipitation patterns during the refill period, but could be complete by the following summer. Once the lake level reaches the Lake Creek outlet, the canal would be closed and surface flow through the Lake Creek outlet would be restored. As during the draw down,

[13] Very cold streams like Silent and Short Creek require utilization of higher concentrations of rotenone to effectively kill fish.
[14] Rotenolone is the metabolite (by product) of rotenone (Finlayson et al. 2000).
[15] The liquid rotenone formulation Noxfish® contains inert emulsifiers, solvents, and carriers that are important in ensuring the solubility and dispersion of rotenone in water. Waters treated with Noxfish® may contain rotenone, rotenolone, and volatile (xylene, trichlorethylene, toluene, and trimethylbenzene) and semi-volatile (naphthalene, 1-methyl naphthalene, and 2-methyl naphthalene) organic compounds. These volatile and semi-volatile organic compounds dissipate in treated water before rotenone and rotenolone (Finlayson et al. 2000).

PacifiCorp would be consulted prior to any flow changes so that they could schedule the routing of water through Lemolo Lake during the refill period.

It is recognized that during the year of treatment, ODFW would be unable to store water in Diamond Lake to satisfy their downstream water right. Thus, if treatment occurred during a dry year, the Rock Creek Hatchery summer water supply could be compromised. PacifiCorp would coordinate with ODFW to route water as efficiently as possible during this time.

Monitoring: A variety of monitoring activities would occur before, during and after project implementation. Appendix BB includes a detailed, site-specific monitoring plan. Monitoring results[16] would be used to verify assumptions, evaluate project success, and formulate appropriate lake management strategies utilizing an adaptive management process. Proposed monitoring activities and general timeframes include, but are not limited to:

- Stream flows, channel morphology, and water quality in Lake Creek would be monitored periodically throughout all phases of project implementation and post-project.
- Water quality in Lemolo Lake and the North Umpqua River would be monitored periodically throughout all phases of project implementation and post-project.
- Diamond Lake water quality would be monitored for a minimum of five years[17] post-project.
- Phytoplankton, zooplankton and benthic invertebrate populations would be monitored for a minimum of five years[12] post-project.
- Extensive monitoring for tui chub presence in Diamond Lake would be conducted for a minimum of five years[12] post-project.
- Trout populations and annual harvest rates would be monitored for a minimum of five years[12] post-project.

Fish Restocking Strategy: ODFW would pursue approval for a change to the following strategy for restocking Diamond Lake with fish through the Oregon Fish and Wildlife Commission (OFWC) and the appropriate public process.

ODFW would utilize monitoring data and adaptive management to determine an ecologically appropriate[18] fish stocking strategy for Diamond Lake for the years following a rotenone treatment. In general, Diamond Lake would be managed for hatchery production under the basic yield alternative of Oregon's Trout Plan (OAR 635-500-0703 and OAR 635-500-0115). However, appropriate numeric goals for annual fish stocking and harvest, post-project, would be determined by ODFW using existing data and knowledge, ecological indices of lake health (i.e., zooplankton and benthic invertebrate populations) described in Eilers (2003a), annual

[16] As described in the monitoring plan in Appendix BB, monitoring results would be compiled at regular intervals and would be available to the public during normal business hours at local ODFW, ODEQ, and Forest Service offices (Diamond Lake Ranger District).
[17] A five year minimum time period is referenced because this represents the normal lifetime of an EIS. However, it is anticipated that this monitoring will occur well beyond five years.
[18] An ecologically appropriate fish stocking strategy is a strategy based on relevant monitoring parameters such as those describe in Eilers (2003a) which allows managers to stock fish in such a way that the ecological balance of the lake is maintained.

fish monitoring data and applicable nutrient loading allocations provided in ODEQ's pending TMDL publication.

Under this stocking strategy, it is expected that conservatively small numbers of fingerling "Fishwich"[19] or Oak Springs rainbow trout and trophy and/or legal sized predacious fish species (Eagle Lake rainbow trout, brown trout, or spring Chinook) would be introduced into Diamond Lake as soon as the food chain recovered adequately to support them without compromising progress toward water quality goals. Annual stocking rates would be expected to increase as the food chain and water quality continued to recover. ODFW would develop a new implementation plan for management of the Diamond Lake fishery when sufficient monitoring data becomes available to predict ecologically sustainable stocking levels.

Education: A number of educational measures would be used for implementation to reduce the likelihood of tui chub reintroduction into Diamond Lake, potentially including but not limited to:

- A required "angler stamp" for persons desiring to fish at Diamond Lake. Stamps would be free to the public (or low cost) and would come with an educational brochure documenting the ecological and economic costs associated with the past introduction of the tui chub into Diamond Lake.
- Interpretive signs documenting the history of the tui chub at Diamond Lake.
- Distribution of interpretive brochures to campers and visitors.
- Boat inspections to detect presence of tui chub in live wells or occurrence of aquatic weeds that could contain viable tui chub eggs (or other invasive organisms). Distribution of educational messages and materials during inspections.
- Interpretive signs and brochures at Lemolo Lake describing recommended or required practices for boaters moving from Lemolo to Diamond Lake (i.e. boat cleaning).

Tui Chub Contingency Plan[20]: Following rotenone treatment, tui chub are not expected to be reintroduced into Diamond Lake by migrating into the lake from inflowing or outflowing streams. As described above, rotenone would be applied to the two inflowing streams of Diamond Lake that support fish and a 5-6 foot waterfall in the one stream that drains Diamond Lake (Lake Creek) would prevent chub from entering the lake from any downstream locations. However, because it is recognized that tui chub may be illegally or otherwise reintroduced into Diamond Lake, several actions designed to control tui chub populations would be implemented:

- An extensive monitoring program would be conducted to facilitate early detection of tui chub presence in the lake. Population control measures are more likely to be effective if there are low numbers of tui chub present.
- ODFW plans to stock Diamond Lake with predacious fish species following a rotenone treatment. These fish would be present in the lake to prey upon chub. If tui chub were

[19] Native rainbow trout strain; the brood stock for these fish was collected from rainbow trout in two upper North Umpqua River tributaries- Mowich and Fish Creeks.

[20] Appendix BB details early chub detection monitoring as a component of the monitoring plan and predacious fish stocking and mechanical fish removal as components of this alternatives contingency plan. For the purpose of alternative comparison over a longer period of time, it is assumed that contingency plans for each alternative would be implemented for five additional years beyond the 7 year project lifetime. Economic estimates for these five years are included as a modification to the economic section of the FEIS.

detected in the lake, ODFW would substantially modify their stocking strategy to include more predacious fish.
- Mechanical treatments including, but not limited to: netting, seining, trapping, electro shocking, and disruption of spawning would be used to limit tui chub population growth.

Implementation of the contingency plan would extend well beyond the lifetime of this project and is primarily the responsibility of ODFW. Appendix BB includes supplemental plans that provide more detailed information about the monitoring, education, and contingency plan components of this alternative.

Connected Actions: The Diamond Lake Resort has informed the Forest Service that they intend to request a permit to accomplish the following projects while Diamond Lake is drawn down to eight feet below its normal level. These activities are "connected actions" under NEPA because they cannot or will not proceed unless the draw down occurs previously (40 CFR 1508.25 (a ii)).

The Diamond Lake Resort proposes the following two projects:

1. Resort Marina Cleanup and Improvements
   This project would remove accumulated sediment (silt) around the Resort Marina on the northeast corner of the lake near the mouth of Two Bear Creek. The Resort also proposes to make needed repairs to parts of the docks that are normally below the water line, and remove accumulated trash from the lake bottom in and around the marina. The affected area is approximately 28,000 sq. ft. (2/3 acre). Resort personnel estimate that there is approximately 1.5-2.0 feet of accumulated sediment/silt near the creek and less away from the mouth of the creek. This equates to a volume of approximately 750-1000 cubic yards of material that would be removed under this proposal. The proposed project would occur at a time of year when Two Bear Creek is normally dry, but if necessary temporary piping would be installed to move any water going down the creek to the water line. A front-end loader or backhoe would be used to accomplish this work. A disposal site for the sediment would be approved by the Forest Service prior to issuance of a permit to complete the work. It is possible that the sediment could be used on the Resort's Permit Area for landscaping or vegetation rehabilitation projects. Dock repairs entail replacing old boards, posts and supports that have not been repaired in decades. Expected project duration is one to two weeks.

2. South Shore Store/Pizza Parlor Dock Area Cleanup
   This project would remove obstacles/water hazards such as old cribbing, concrete blocks, pilings, etc. that are remnants of old boat docks and moorage. Many of these obstacles are just below the normal water line and are an existing boating hazard. Equipment needed to accomplish this work would be a small Bobcat© or back hoe and dump truck. Expected project duration is one week.

Alternative 3 (Put and Take Fishery)

Alternative 3 responds to the fish stocking issue. This alternative is designed to provide a "good"[21] recreational fishery that minimizes potential effects of fish on water quality in Diamond Lake. Alternative 3 is identical to the proposed action except that it would utilize a different fish stocking strategy to restock Diamond Lake following a rotenone treatment.

Alternative 3 includes all of the following components of the proposed action described in Alternative 2*: **canal reconstruction, fall/winter lake draw down, mechanical fish removal and utilization, rotenone treatment, non-significant amendment to LRMP, mechanical fish carcass removal and utilization, water management during the lake refill period, monitoring, education, and a tui chub contingency plan***. Primary implementation responsibilities for lead and cooperating agencies are the same as described for Alternative 2. Appendix BB includes supplemental plans that provide more detailed information about the monitoring, education, and contingency plan components of this alternative.

Additionally, under this alternative, ODFW would pursue approval for a change to the following strategy for restocking Diamond Lake with fish through the OFWC and the appropriate public process.

If approved by OFWC, management of the Diamond Lake recreational fishery would change from a Basic Yield Alternative under Oregon's Trout Plan (OAR 635-500-0703 and OAR 635-500-0115(4)) to an Intensive Use Alternative (OAR 635-500-0115(5))[22]. In layman's terms this is a "put and take fishery" where legal sized fish are stocked in the spring and are harvested by anglers later in the same season.

Under this stocking strategy, it is estimated that ODFW would stock Diamond Lake annually with approximately 100,000-400,000, 12" domesticated rainbow trout. Trout from this brood stock would not reproduce successfully in Diamond Lake, would not prey significantly on available food organisms, and the majority would not survive over winter. Diamond Lake would be stocked with domesticated trout in late spring following a fall rotenone treatment (since these fish would not require a robust existing food base). Stocking would occur periodically from late spring to early fall on an annual basis.

Subsequently, as part of the "tui chub contingency plan", legal or trophy sized predacious fish species (Eagle Lake rainbow trout, brown trout, or spring Chinook) would be introduced into Diamond Lake as soon as the food base recovered adequately to support them without compromising progress toward water quality goals. Ecological indices of lake health (i.e., zooplankton and benthic invertebrate populations) described in Eilers (2003a), existing data and knowledge, annual fish monitoring data and applicable nutrient loading allocations

[21] In general, a "good" recreational fishery represents a substantial improvement over the current fishery, but would not be expected to achieve the status of an "excellent" fishery such as existed at Diamond Lake during its previous peak period as a recreational fishery.

[22] Intensive Use--"….Waters managed for this alternative are apt to be near large population centers or attract intensive angler use because of easy accessibility or location of other water-oriented recreational facilities. Many of these waters support fisheries year-round. Many of these waters can be used heavily by anglers or for short periods (April, May, and June) and afterwards be used for sailboating, water skiing, swimming, and camping. Other waters can support fisheries year-round. Some of these waters are stocked with yearling rainbow trout on a regular basis. Guidelines which apply are:…." (OAR 635-500-0115(5).)

provided in ODEQ's pending Total Maximum Daily Load (TMDL) publication would be used to determine appropriate numeric goals for all annual fish stocking and harvest post-project.

Connected Actions: Connected actions by the Diamond Lake Resort are the same as those described in Alternative 2.

Alternative 4 (Mechanical/Biological)

Alternative 4 was modified to respond to public comments on the Draft Environmental Impact Statement (DEIS) that requested changes in the proposed tui chub removal techniques and fish stocking strategy for Alternative 4, as well as the addition of a contingency plan to the alternative. All modifications were designed to increase the potential effectiveness of the alternative at achieving and maintaining improved water quality and an improved recreational fishery in the long-term. This alternative description differs from the alternative description in the DEIS in that it includes: a more detailed description of the potential tui chub removal techniques; a fish stocking strategy that uses a larger number of larger-sized predacious fish, but does not consider use of catch and release regulations; a contingency plan that extends for 5 additional years beyond the 7-year project lifetime[23]; and an adjusted economic analysis.

Alternative 4 responds to the issues of fish stocking, non-target species, water quality, wetland ecology, and human health risks associated with rotenone use. This alternative is designed to minimize effects of a chemical treatment and associated lake draw down on resources while limiting/controlling the tui chub population. This alternative does not include a lake draw down so potential impacts to water quality and wetland ecology from a draw down are eliminated; and it does not include a chemical treatment so potential impacts to non-target species, water quality, and health risks from chemicals are eliminated. This alternative includes a modified fish stocking strategy designed to reduce the potential impacts of a recreational fishery on water quality in Diamond Lake.

Alternative 4 would use mechanical techniques in combination with predacious fish stocking to selectively harvest chub, disrupt chub spawning and increase predation on chub, with the objective of severely diminishing chub populations over time. Alternative 4 includes the following components of the proposed action described in Alternative 2: ***education*** and ***monitoring***[24]. Additionally, this alternative includes all of the following components:

Annual Mechanical Harvest: Following one year of equipment and technique testing and experimentation, mechanical fish harvest treatments would occur on an annual basis for six consecutive years utilizing a variety of commercial[25] fishing tools/techniques determined to

[23] An additional year has been added to the project lifetime in the FEIS to accommodate one year of research and testing prior to implementing full scale mechanical removal efforts. This was necessary because it is expected to take six years of full scale mechanical operations to achieve project objectives. Under the DEIS, this testing would have occurred in 2004, prior to the described 6 years of alternative implementation; it is no longer possible to accomplish testing prior to implementation thus, the timeline has been adjusted to accommodate this reality.

[24] Additional monitoring of the tui chub population would occur under this alternative during the lifetime of the project. Proposed monitoring is described in the Alternative 4 monitoring plan which is part of the project record.

[25] Commercial in this context and throughout this alternative description does not adhere to the traditional definition of the word; here it means that tools/techniques used by commercial fisherman would be used to accomplish chub

be most effective through an adaptive management process. Potential tools include: seine nets, trawl nets, cast nets, gill nets, lampara[26] and beach seines, custom-built traps, or other types of commercial nets, seines, and traps. Mechanical fish harvest treatments would target reproductive age chub. The goal of these activities would be to harvest 90-95%[27] (or more) of the reproductive-age chub annually, while attempting to maintain a biological control (predacious fish) on the tui chub population

Although utilization of adaptive management could result in many changes to such details as net and trap sizes and techniques employed, the following describes the anticipated implementation plan for this alternative:

A combination of active and passive commercial fishing methods (beach seine nets, boat seine nets, and fish traps) would be used to remove as many spawning-size chub as possible each year. Commercial fishing activities to harvest tui chub would likely occur for two months in June and July prior to and during the chub spawning period at Diamond Lake. Commercial fishing would also occur annually for approximately one month in September in an effort to harvest chub as they move from the shallows into more open water within the lake.

Commercial fishing operations would only occur in certain portions of the lake at a given point in time and would be rotated to different portions of the lake during the two month period. Areas where commercial fishing was occurring would be closed to recreational angling. Marker buoys, lights, signs, GPS and a look out would be used to mark the boundaries of active commercial fishing. Maps and educational materials explaining the fishing operations would be distributed throughout the area.

Commercial fishing tools/techniques would be tested and modified to increase efficiency through an adaptive management process. Under this alternative, trap and net testing and scientific research would occur during the first year of implementation. In approximately 2005, a large scale experimental commercial fishery, one to three months in duration, would be implemented. Traps to be tested are about six to seven feet on a side and twenty-five feet long with several capture chambers. These traps would be set on the bottom of the lake and held in place with weights. Fish would be led into the trap by two or three long nets staked to the bottom. Traps would be most effective when the fish are moving into or out of shallow water for spawning. Fish would be herded into the traps by setting a seine or containment net leading from the deep water outside the trap to the beach and slowly closing the net to force the fish into the trap.

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removal. There is no known "commercial" market for chub and fisherman would be paid to remove chub under a contract.

[26] A lampara net is a type of open water seine with tapered ends and a relatively deep, loosely hung center section. The net is set in a circle around the fish school and the two ends are brought together capturing the fish in the middle (Nielsen and Johnson 1989).

[27] Success of this alternative hinges upon removal of 90-95% of spawning age tui chub on an annual basis for six consecutive years. Rationale for these percentage are contained in an ODFW population modeling report (Jackson and Loomis 2003) and in a nutrient modeling report prepared for ODEQ by Maxdepth Aquatics in support of the TMDL for Diamond Lake (Eilers et al. 2003).

Active netting techniques would also be tested. Boat and beach seining and set and drift gillnetting are considered to be the most likely to succeed. Techniques to minimize[28] the mortality of trout and other desirable fish unintentionally caught in the nets and traps would be implemented. Minnow traps would also be used to catch smaller chub. A variety of bait (including brine shrimp), would be tested to find the bait that can best attract the small chub.

Two Alaska-style seine skiffs, approximately 20 to 24 feet in length, would be used in the commercial fishery. A total of six crew would be needed for three months. A minimum of 25 fish traps and 200 minnow traps would be needed during the commercial fishery. A boat seine net a minimum of 2,000 feet in length by 10 to 15 feet deep would most likely be used. This net would be constructed with quarter-inch mesh nylon netting backed by a stiffer, larger mesh monofilament net.

A fish offloading and holding facility[29] and a fishing equipment maintenance and storage area would be established near the lake shore[30]. The fish waste would be collected and hauled to Astoria's fish food pellet plant, some other facility, or otherwise appropriately used (i.e. emulsification).

At the end of the first full mechanical harvest (commercial fishing) season, all participating parties, including the public, would conduct a review of the commercial fishery. Modifications would be undertaken based on the recommendations of the Diamond Lake Restoration Working Group.

Spawning Disruption: In addition to the above activities, electro fishing boats would be used during the peak chub spawning period to disrupt spawning in the shallow areas of the lake that have abundant aquatic macrophytes. Where vegetation and bottom contour are favorable, a beach seine would be used to capture spawning fish in shallow areas. Nets may also be deployed to exclude fish from favored spawning areas of the lake. Electro fishing equipment may also be used to move small tui chub out of the weeds and into the nets and traps.

Fish Stocking Strategy: ODFW would pursue approval for a change to the following strategy for stocking Diamond Lake with fish through the OFWC and the appropriate public process. In general, Diamond Lake would be stocked annually with large predacious fish in sufficient numbers and of sufficient size/age classes to serve as potentially effective predators on the tui chub. Enough catchable size trout would be released into the lake to support an improved recreational fishery. Specifically, if approved by OFWC, management of the Diamond Lake recreational fishery would change from a Basic Yield Alternative under Oregon's Trout Plan

[28] Excluder devices are commonly used in net fisheries to allow non-target species (turtles, rockfish, halibut) to escape. Hand sorting and dip netting may also be used to remove non-target fish.
[29] Implementation cost estimates include $1,000 a week for on-site cold storage to facilitate hauling to Astoria.
[30] An appropriate location with good access by both water and road would be selected prior to implementation.

(OAR 635-500-0703 and OAR 635-500-0115(4)) to either a Featured Species[31] (OAR 635-500-0115(2)) or Trophy Fish Alternative[32] (OAR 635-500-0115(3)).

OAR 635-500-0115(4)(b) under the Basic Yield Alternative states: "The productive capacity of the waters in this alternative will be maintained or enhanced so that no net loss of natural fish production occurs. Problem waters[33] can be transferred into a higher priority alternative." Both the "Featured Species" and "Trophy Fish" alternatives are higher priority alternatives in the Oregon Trout Plan.

A Featured Species stocking strategy would include annual stocking with legal and/or trophy sized Eagle Lake rainbow trout (or other predacious fish). A Trophy Fish stocking strategy would include annual stocking with legal and/or trophy sized brown trout or Kamloops rainbow trout.

Ecological indices of lake health (i.e., zooplankton and benthic invertebrate populations) described in Eilers (2003a), existing data and knowledge, annual fish monitoring data and applicable nutrient loading allocations provided in ODEQ's pending Total Maximum Daily Load (TMDL) publication would be used to determine appropriate numeric goals for annual fish stocking and harvest post-project. However, the following summarizes estimated fish stocking under this alternative:

> **2005**: 15,000 – 20,000 two to four pound predacious trout or other predacious fish and 85,000 catchable to trophy size domestic rainbow trout
>
> **2006:** 15,000 – 20,000 two to four pound predacious trout or other predacious fish and 150,000 catchable to trophy size domestic rainbow trout
>
> **2007 – 2011:** 7, 500 – 10,000 two to four pound predacious trout or other predacious fish and 230,000 catchable to trophy size domestic rainbow trout

This alternative would use experimental stocking and adaptive management to select a species of predacious fish to be introduced into the lake in subsequent years to serve as predators on the tui chub. During the first year of implementation (approximately 2005), several strains of trout and other species of fish in the two to four pound range would be stocked and evaluated for their effectiveness as tui chub predators. All would be artificially sterilized and all would be visually marked. A recreational angler reward program as well as the commercial fishery could be used to recapture these study fish to examine their stomach content and estimate growth and survival rate. Additionally, a domesticated strain of trout in a range of sizes would be stocked each year in sufficient number to support a robust sport fishery. Anglers would be allowed to keep both large predacious fish as well as the catchable sized domestic rainbow trout.

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[31] "Featured Species and Waters—Management under this alternative emphasizes species or stocks that are uncommon or unique and waters that have historical benefit or potential for unique natural beauty, water quality, aesthetics or recreational capabilities…" (OAR 635-500-0115(2))

[32] "Trophy Fish—Certain waters are capable of producing large "bragging-size" trout …"(OAR 635-500-0115(3))

[33] Problem waters are not defined in the OARS however, according to ODFW personnel, the degraded water quality at Diamond Lake qualifies it as "problem water".

Alternative Contingency Plan: It is expected that following 6 years of full scale mechanical removal (approximately 2011), the tui chub population in Diamond Lake would be greatly diminished. It is also acknowledged that annual tui chub removal and spawning disruption activities would be needed to effectively limit tui chub recruitment in Diamond Lake over time. Additionally, it is assumed that the likelihood of achieving or maintaining improvements in the water quality and recreational fishery in the long-term[34] under this alternative would be increased with annual implementation of the following contingency plan:

- Annual sampling and tui chub population modeling would occur to facilitate determination of the appropriate level and duration of tui chub removal activities necessary in a given year[35]. Population control measures are more likely to be effective if low numbers of tui chub are maintained. Additionally, low numbers of tui chub must be maintained in order to sustain an improved recreational fishery without exceeding nutrient allocations for water quality.
- Annual stocking with large predacious fish of the size and species determined to be most effective at consuming tui chub would occur. Appropriate numbers would be determined based on the tui chub population size estimates and nutrient allocations described in the TMDL.
- Annual mechanical treatments including, but not limited to: netting, seining, trapping, electro shocking, and disruption of spawning would be used to limit tui chub population growth.

Additional details concerning this contingency plan are documented in Appendix CC of the FEIS. Additional details concerning monitoring are documented in a monitoring plan that is part of the project record.

Primary responsibilities for lead and cooperating agencies are:

The Forest Service would: 1) authorize operation of fish carcass processing on National Forest system lands (accomplish with an MOU – FSM WO Amendment 1500-96-9 effective 10/16/96, 1561.21); 2) and assist in implementation of partial lake closures, educational and monitoring activities.

ODFW would: 1) authorize and manage commercial fish harvest operations (ORS 506.129 (subsection 1)); 2) pursue approval for the proposed fish stocking strategy through the Oregon Fish and Wildlife Commission (OFWC) and the appropriate public process(ORS 496.012); and 3) assist in implementation of partial lake closures, educational and monitoring activities.

ODEQ would: 1) assist in implementation of educational and monitoring activities (no water quality permits would be required for this alternative).

[34] For the purpose of alternative comparison over a longer period of time, it is assumed that contingency plans for each alternative would be implemented for five additional years beyond the 7 year project lifetime. Economic estimates for these five years are included as a modification to the economic section of the FEIS.

[35] Monitoring results will be used to determine actual required level of effort. For analysis purposes, during contingency plan implementation, it is assumed that the level of mechanical removal would be reduced by about one third or one month each year during peak spawning. This is based on the assumption that knowledge of chub behavior and preferred habitats would be refined such that a one month effort is adequate to control rate of population growth.

Alternative 5 (Modified Rotenone Treatment and Post-Treatment Fish Stocking)

Alternative 5 was developed to respond to public comments on the Draft Environmental Impact Statement (DEIS) related to the rotenone treatment and the fish stocking strategy. This alternative would rely more on the use of the liquid rotenone formulation and it would target the upper range of recommended rotenone concentrations for use on chub-like species as compared to Alternatives 2 and 3. As such, Alternative 5 is predicted to increase the likelihood that a rotenone treatment would kill 100% of the tui chub present in the lake at the time of treatment. Alternative 5 also reflects the post-treatment fish stocking strategy described by ODFW after publication of the DEIS (Appendix AA – Letter 77 and Appendix D – August 19, 2004, Preliminary Stocking Plans for Diamond Lake for FEIS Alternatives).

Alternative 5 includes all of the following components of the proposed action described in Alternative 2***: canal reconstruction, fall/winter lake drawdown, mechanical fish removal and utilization, non-significant amendment to LRMP, mechanical fish carcass removal and utilization, water management during the lake refill period, monitoring, education, and a tui chub contingency plan***. Primary implementation responsibilities for lead and cooperating agencies are the same as described for Alternative 2. Appendix BB includes supplemental plans that provide more detailed information about the monitoring, education, and tui chub contingency plan components of this alternative. Additionally, Alternative 5 includes the following components:

Modified September Rotenone Treatment: Both powdered (Pro-Noxfish®) and liquid (Noxfish®) formulations of the fish toxicant rotenone would be applied to Diamond Lake in September when water temperature and chemistry reached conditions considered optimal for achieving a complete fish kill. Both types of rotenone would be administered according to label instructions at the necessary amounts based on water volume, temperature, and chemistry in Diamond Lake at the time of application. As with Alternatives 2 and 3, prior to application, site-specific bioassay tests would be conducted on tui chub utilizing rotenone from the stock to be used in lake treatment and water from Diamond Lake. However, based on recommended application rates, advice from a leading expert in the use of rotenone in fisheries management (ODFW 2004a), mean temperature and pH observed in Diamond Lake in September, and predicted water volumes, the following represents the estimated rotenone application plan that would be used to treat Diamond Lake proper.

Under Alternative 5 liquid rotenone would be applied to shallow waters less than about 20 feet in depth at an active rotenone concentration of 0.1 ppm. Based on a predicted water volume of 13,300 acre-feet following the drawdown, it is estimated that approximately 8,900 gallons of liquid rotenone would be used in the lake. The shallow waters of Diamond Lake are dominated by aquatic plants (macrophyte beds) that provide optimal habitat for tui chub. The use of liquid rotenone in these shallow areas was suggested by expert personnel from the California Department of Fish Game, to increase the likelihood of full chub eradication. The liquid formulation is considered more effective in such environments because it disperses more quickly and thoroughly than the powder form.

Under Alternative 5, powdered rotenone would be applied to the rest of the lake water, greater than 20 feet in depth, also at an active rotenone concentration of 0.1 ppm. Based on a predicted water volume of 31,000 acre-feet following the drawdown, it its estimated that approximately 168,000 pounds of powdered rotenone would be used in the lake. Powdered rotenone is the recommended formulation for the deeper areas of the lake because it would disperse adequately and is less expensive.

Alternative 5 would treat Silent and Short Creeks exactly the same as Alternatives 2 and 3, by using the liquid formulation, Noxfish®, as described above for those alternatives. Thus, approximately 470 yards of Silent Creek and 550 yards of Short Creek, would receive liquid rotenone at 0.1 ppm at drip stations. All other aspects of rotenone transport, storage, application, and safety management would be the same as described for Alternatives 2 and 3.

Modified Fish Stocking Strategy: Under this alternative, ODFW would restock Diamond Lake with fish following the rotenone treatment as described in Director Lindsay A. Ball's, July 2, 2004 letter (Letter 77 in Appendix AA) and in ODFW's August 19, 2004 memo, "Preliminary Stocking Plans for Diamond Lake for FEIS Alternatives"(Appendix D). The following summarizes ODFW's proposed fish stocking strategy as described in these two documents based on a fall 2006 rotenone treatment:

- ODFW would continue to manage for both maintenance and experimental fisheries through 2008, provided a rotenone treatment is successfully completed in 2006.
- ODFW would design and recommend a post-treatment stocking strategy that best meets the goals of the lake based on the following environmental indices described in Eilers (2003a), "An Ecologically-Based Index for Guiding Salmonid-Stocking Decisions in Diamond Lake, Oregon": pH, dissolved oxygen, chlorophyll *a*, phytoplankton biovolume, Sechhi disk transparency, percent rotifers, percent edible zooplankton, and percent amphipods in the zoobenthos.
- Actual stocking numbers could vary based on a number of factors including availability of eggs/fish, facility capacity, actual costs, available funding, monitoring results and management decisions; however, the following describes approximate stocking strategies from 2005 – 2011, based on ODFW's current budget (ODFW 08-19-2004, Memo):

  2005: 24,000 catchable-size trout; 18,000 put-and-take-trout and 3,000 trophy-sized trout;

  2006: 24,000 catchable-size trout (early season only);

  2007[36]**:** 50,000-100,000 fingerlings and 10,000-25,000 catchable-size predacious trout**;**

[36] According to ODFW's July 2, 2004 letter and personal communications with Dave Loomis in the years 2007- 2010, it is possible that a minimum of 50,000 put-and-take-size trout would also be stocked in Diamond Lake if sufficient additional funding is secured. However, due to the high level of uncertainty, these additional fish were not included in ODFW's subsequent August 19, 2004 memos and thus are not included in the alternative description or elsewhere in the document.

2008[36]**:** 100,000-200,000 fingerlings and 10,000-25,000 catchable-size predacious trout;

2009[36]**:** 100,000-300,000 fingerlings and 10,000-25,000 catchable-size predacious trout;

2010-2011[36]**:** 200,000-300,000 fingerlings and 10,000-25,000 catchable-size predacious trout.

- In compliance with their statutory authority and related policies and plans ODFW would design and implement an ecologically sound stocking strategy. OFWC would enter into a public review of the Diamond Lake Management Plan when sufficient information is available regarding the fishery that can be maintained in the long term. This decision process would take into consideration the environmental, biological, economic, and community values of the people of Oregon.

Under this alternative, by law and by mutual agreement between the USFS, ODFW and ODEQ, applicable nutrient loading allocations provided in ODEQ's pending TMDL publication would be used to determine appropriate numeric goals for annual fish stocking following a rotenone treatment. ODEQ's role and commitment to participate and assist are documented in Letter 78, Appendix AA, incorporated by reference into the body of this document. In compliance with the TMDL's beneficial uses, appropriate stocking numbers and timing of fingerling size fish releases would not occur post-treatment until zooplankton levels and community composition fall within agreed ranges for supporting water quality recovery and the ecological health of the lake.

Connected Actions: Connected actions by the Diamond Lake Resort are the same as those described in Alternative 2.

REFERENCED LOCATIONS

Figures 4a and 4b illustrate the location of areas referenced under project alternatives or in mitigation and monitoring descriptions in this chapter.

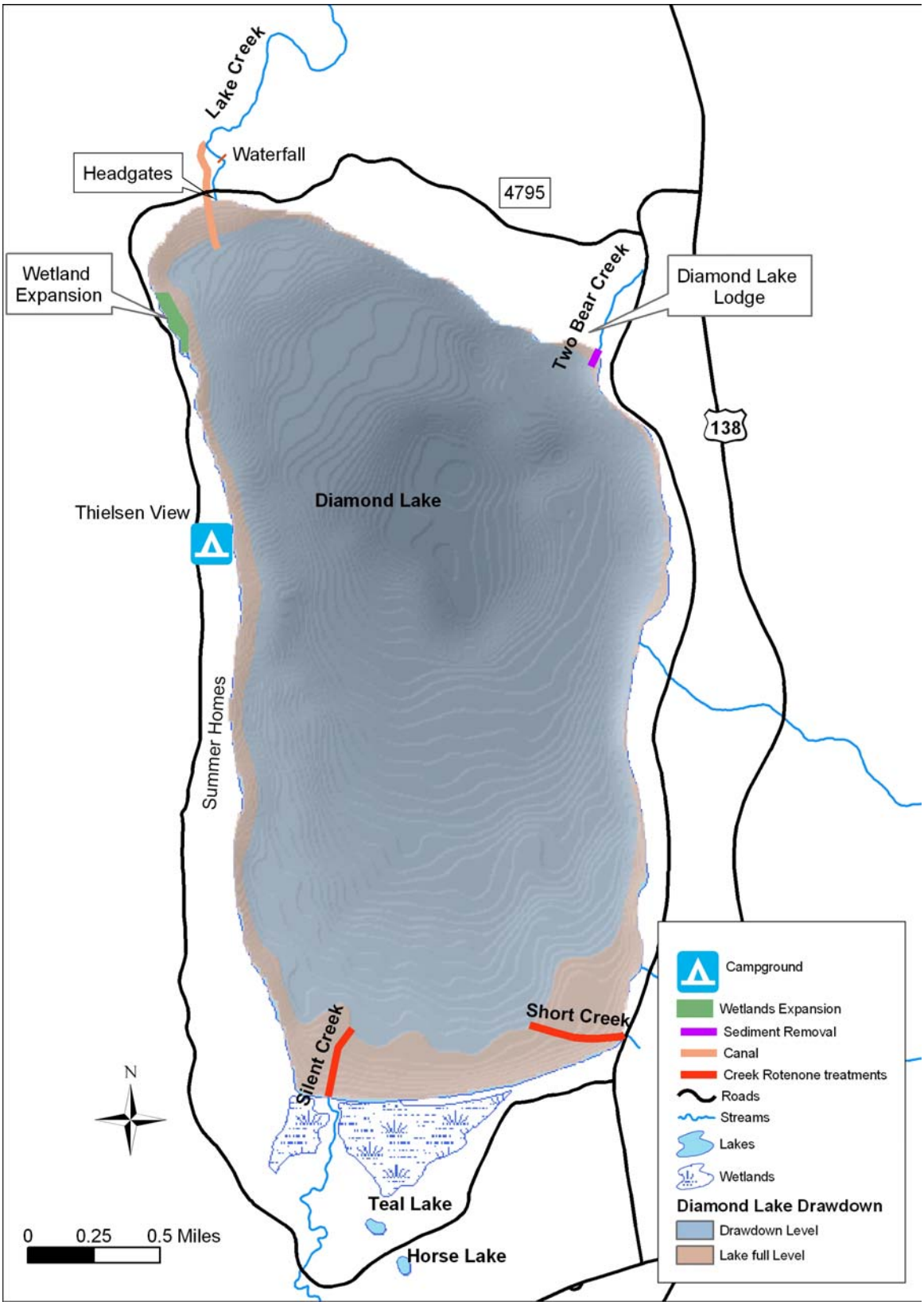

Figure 4a. Referenced areas in the Diamond Lake project area.

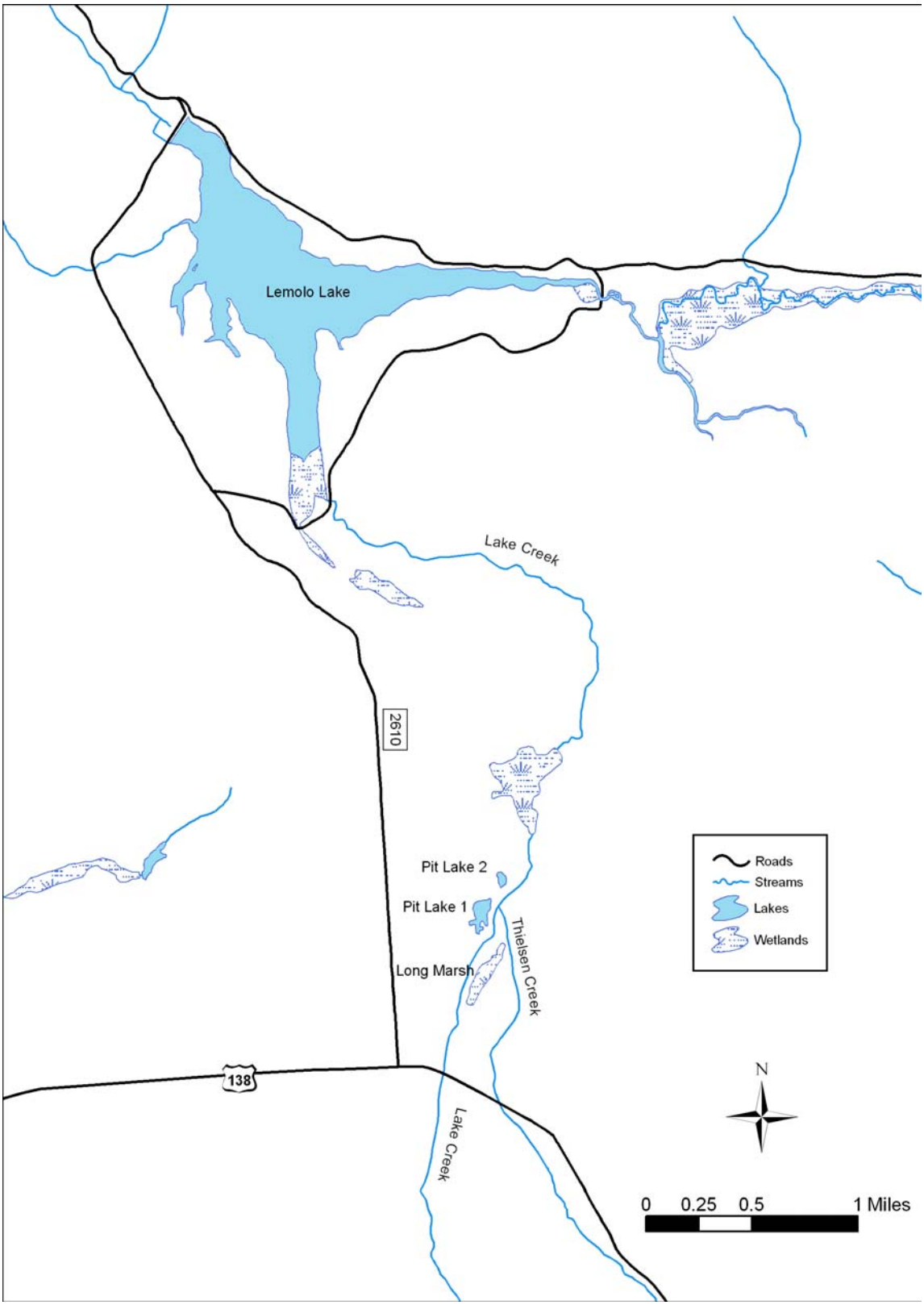

Figure 4b. Referenced areas in or adjacent to the Diamond Lake project area.

BEST MANAGEMENT PRACTICES, MANAGEMENT REQUIREMENTS, MITIGATION MEASURES, AND MONITORING

The following measures apply to Alternatives 2, 3 and 5 or as otherwise stated. These requirements will be implemented in order to meet laws, regulations, and policies. In most cases they have been designed to reduce potential environmental effects. General Water Quality Best Management Practices (BMPs) are prescribed to protect the beneficial uses of water and to address water quality objectives as required by the Federal Clean Water Act and the 1990 Umpqua National Land and Resource Management Plan, as amended. Each BMP is listed by the code used in the Pacific Northwest Regional Guide called General Best Management Practices. BMPs are differentiated by a check mark (✓), management requirements not related to compliance with the Clean Water Act are indicated by a round bullet (•), and monitoring is delineated by a lightning bolt (↯); monitoring previously listed as part of each action alternative is incorporated by reference. Standards and Guidelines (S&Gs) from the LRMP and Northwest Forest Plan are also listed. Table 1 summarizes permits required for implementation of each alternative.

WATERSHED MANAGEMENT
BMPs R-2, R-5, R-7, R-10, R-15, W-3, W-4, W-7, REC-3,T-21. Forest Plan S&Gs IV-12 (#5); IV-33 (#2); IV-61 (#9, 12); IV-62 (#14, 17, 20, 21); IV-68 (#5); IV-71 (#13); IV-72 (#16)IV-81 (#2); IV-82 (#3, 4, 5, 6); NWFP (RF-2, RF-4, RM-3, RA-3; FSM 7500, FSH 7500.

OBJECTIVES: To maintain or improve watershed conditions.

ACTIONS:

- ✓ An Erosion Control Plan will be submitted by the contractor and approved by Forest Service prior to starting work. The plan will limit and mitigate erosion and sedimentation through effective planning prior to initiation of road/trail reconstruction activities and through effective contract administration during reconstruction.

- ✓ Road slope and waste area stabilization will minimize soil erosion from cut slopes and fill slopes along Road 4795, and waste areas. Depending on soil, slope, climate, and proximity to water, methods will require vegetative and/or physical restraint measures to provide for adequate surface soil stability.

- ✓ Control surface road drainage associated with access road (especially adjacent to the canal) to minimize the erosive effects of road water concentration and the sediment generated from access roads. Dispersal of runoff from access roads will be accomplished by such methods as rolling the grade, insloping with cross drains, outsloping, crowning, installation of water spreading ditches, etc. Disconnecting or interrupting the flow path from the access road to water will reduce sediment delivery.

- ✓ Construct stable embankments (fills) with materials and methods, which minimize the possibility of failure and subsequent water quality degradation. Methods of road and canal embankment stabilization will be determined during the design process.

- Crossing and canal reconstruction at Lake Creek will minimize sedimentation and turbidity resulting from excavation for in-channel structure. Sediment producing materials will not be left within reach of anticipated high flows. When needed for work at Lake Creek, bypass and access roads shall be suitably located with plans made for their subsequent obliteration and stabilization.

- ✓ Conduct periodic monitoring of the 4700-710 and Highway 138 road – stream crossings during the draw down period and during rain-on-snow (flood) events. Develop a plan to install a temporary trash rack upstream of the 4700-710 road and a methodology for removing woody debris from culverts below Highway 138 in the event of plugging.

- ✓ Conduct monitoring at landslide sites 3, 4, and 6 where bankfull flow conditions during draw down are likely to result in sediment delivery. Site surveys will be conducted prior to and immediately following draw down to determine the approximate volume of sediment delivered into Lake Creek.

- ✓ Conduct monitoring on the Pit Lake No. 1 material source to determine if stream channel movement would breach the earthen berm that forms the eastern edge of pit development.

- ✓ Toilet facilities would be provided at work sites. Facilities would be planned, located, operated, inspected and maintained to minimize the possibility of water contamination.

- ✓ Ensure that debris generated during road and canal reconstruction is kept out of waterways and properly disposed.

- ✓ Protect wetlands to avoid adverse water quality impacts associated with the expansion of wetlands located in the northwest corner of the lake. Erosion control measures will be identified in design process to address new wetland stability and lake water quality.

- ✓ An Oil and Hazardous Substance Spill Contingency Plan and Spill Prevention Control & Countermeasure (SPCC) Plan will be required if the volume of fuel used for barging, commercial fishing and/or other activities exceeds 660 gallons in a single container or if total storage at a site exceeds 1320 gallons to prevent contamination of waters from accidental spills. This applies to all action alternatives.

- ✓ Servicing and refueling of equipment will be conducted away from waters in the project area to prevent pollutants such as fuels, lubricants, and other harmful materials from being discharged into water.

- The drivable surface on the exposed lake bottom that would potentially be used for transporting mixed chemicals to open water will be a temporary structure or armored surface to minimize area of impact and provide a safe and stable surface.

✓ Rotenone mixing will occur in designated areas, well away from waters in the project to control the risk of contamination to non-target areas and waters. A water source for mixing will be designated.

- Rotenone concentration levels will follow the EPA approved label directions. This includes strict adherence to application rates, mixing methods, rinsing, and disposal of containers.

- Licensed applicators will be required and responsible for all phases of rotenone application.

✓ Storage of rotenone on-site will be at designated areas and security will be provided 24 hours/day to prevent human health risk and vandalism. Enough potassium permanganate (rotenone neutralizer) to neutralize the largest container rotenone will be stored on site.

- Water safety rules and requirements designated by the Oregon State Marine Board will be followed by the applicator and Forest Service Personnel to prevent boating-type accidents.

✓ Lake water testing will be done prior to the release of water from Diamond Lake to ensure that rotenone, rotenolone, and all semi-volatile and volatile organic compounds associated with the chemical treatment have dissipated to non-detectable or trace levels in both the water column and lake bottom sediments.

✓ Diamond Lake's surface elevation and Lake Creek's flow will be monitored during the draw down and pass-through flow phases to ensure that outflow from the Diamond Lake is regulated to meet the intended project outcome and that flow conveyed to Lake Creek remains within desired range.

✓ Control structures at the Lake Creek outflows will be reconstructed to an elevation that would contain water in Diamond Lake in the event that unexpectedly high amounts of precipitation occur following the rotenone application.

- Canal outlet control structure design and management will meet the requirements of a Class D, Moderate Hazard dam in compliance with FSM 7500 and FSH 7500.

HUMAN HEALTH AND SAFETY
BMPs W-7, REC-1, REC-5, REC-10; FOREST PLAN S&G IV-63 (#20, 21).

OBJECTIVE: To reduce human health risk associated with a rotenone treatment.

ACTIONS:

- The protective equipment listed on the labels of both rotenone formulations and potassium permanganate (should it be used to neutralize spills) would be used by all personnel who handle these products. This includes disposable coveralls, gloves, eye protection, face shields, nitrile gloves, and air purifying respirators. Extra amounts of cleansing water and all protective equipment and supplies will be on hand at all times during transport, storage, and application.

- All of the following detailed plans will be completed according to the recommendations and examples provided in the "Rotenone Use in Fisheries Management: Administrative and Technical Guidelines Manual" (Finlayson et al. 2000) prior to project implementation: rotenone application plan, site safety plan, site security plan, and a spill contingency plan.

✓ Diamond Lake would be closed to the public during the rotenone application period and only reopened when safety concerns were eliminated. Reopening will be determined by continual monitoring of the assessment wells, the lake water, and the water in lower Lake Creek.

- Community residences and businesses would be notified at least 72 hours prior to the application of rotenone in Diamond Lake and would be informed about what they can do to minimize pesticide exposure.

- A hot line, in cooperation with Douglas County Health Department, would be established to collect reports of any suspected pesticide-related illnesses potentially associated with the project.

✓ Bottled water will be supplied to all potentially impacted wells along the western shore of the Lake from Thielsen View Campground to Silent Creek should rotenone or other added ingredients be detected in any of the Forest Service monitoring wells along the west shore.

✓ The summer home residents who use wells that tap the shallow aquifer (those less than 100 feet deep) for domestic water would be notified in advance and required to use the supplied bottled water if rotenone or its other ingredients are detected in the monitoring wells. Monitoring of well water would occur to determine when well use could resume.

- The potassium permanganate (a rotenone neutralizer) would be kept away from any other oxidizing compounds and any flammable products such as gasoline, oil and alcohol.

FISHERIES
OBJECTIVES: To maintain viable populations of zooplankton and benthic invertebrates.

ACTIONS:

- ✓ Prior to ODFW's restocking of the lake with fish, if monitoring reveals a slow recovery of zooplankton numbers and diversity and/or slow benthic population and species diversity recovery, recovery would be facilitated by adding these organisms from appropriate sources[37].

- A trap will be installed to minimize fish movement out of Diamond Lake during the draw down portion of the project to limit escape of tui chub. This trap will consist of stationary trap nets in combination with block nets or weirs.

GROUNDWATER
BMPs W-7, REC-5; FOREST PLAN S&G IV-63 (#20, 21).

OBJECTIVE: To protect drinking water of summer home residents.

ACTIONS:

- ✓ Monitor ground water and evaluate flow patterns prior to and following the application of rotenone. If monitoring indicates rotenone is migrating toward the west shore summer cabin wells, the Forest Service will notify the cabin owners with an advisory not to consume the water, and will provide the cabins owners with bottled drinking water until it has been determined that the rotenone and rotenone by products are not present in the wells.

- ✓ Provide water to cabin owners whose wells go dry as a result of implementing these alternatives.

[37] Appropriate sources, and collection and handling procedures, are currently being identified by experts on zooplankton and benthic species.

WILDLIFE MANAGEMENT
FOREST PLAN S&G IV-37 (#9).

OBJECTIVES: To maintain populations of eagles, osprey, amphibians, mollusks, and landbirds.

ACTIONS:

- Implement a supplemental bald eagle and osprey feeding program during the time period when the fish population in Diamond Lake is non-existent or limited (a detailed plan would be developed jointly by the USFWS, ODFW, and the USFS).

- Monitor osprey and bald eagle reproductive success during the supplemental feeding program and for two years following restoration of the fish prey base (eagle reproductive success would be monitored annually until the species is delisted).

- Complete post-project monitoring for amphibians in Diamond, Horse, and Teal Lakes. If amphibian populations and species diversity do not recover naturally, transplant individual amphibians from Long Marsh, Pitt Lakes, and Three Lakes (known long-toed salamander breeding area) into suitable habitat in Diamond, Horse, and Teal Lakes to facilitate recolonization of amphibians in these areas.

- Conduct pre- and post- draw down monitoring of soil moisture and species presence at known sites of the Crater Lake tightcoil snail. If post-project surveys reflect that the species appears to be absent at any of the sites, translocate individuals from adjacent known sites with multiple adults (i.e. Crystal Springs) to repopulate the site.

- Conduct pre- and post- draw down monitoring of Silent Creek wetlands to determine how temporary habitat manipulation impacts utilization of habitat by Lincoln's sparrows.

- For Alternative 4, to the greatest extent practical, disentangle and free non-target birds or mammals that become entangled in fishing nets.

RECREATION
BMP REC-10; Forest Plan S&G IV-24 (#5).

OBJECTIVES: Protect scenic quality and visitor experiences.

ACTIONS:

- Introduction of building materials for permanent use will be comprised of, or emulate, the appearance of natural materials and colors normally found in the natural environment such as wood and stone so that it blends with the surrounding terrain.

- Use of interpretive, directional and warning signs, including floating hazard signs on Diamond Lake, will follow a family of shapes and color schemes that are designed to (1) minimize the incongruence of signs in the natural environment; (2) carry consistent

messages through familiarity of style; and (3) link through design with brochures, posters or other printed material used for education and safety.

- Major construction and reconstruction of sites such as the canal, road, bicycle trail, pier extensions, etc. will be shaped and blended to fit the natural environment and earthen surface areas rehabilitated to a finished and vegetated condition.

- Vegetation used for landscaping and rehabilitation of reconstruction sites will be native and require low maintenance.

- For Alternatives 2, 3, 4, and 5, a Public Information Plan will be developed to inform and advise the public about ongoing operations.

- For Alternatives 2, 3, 4, and 5, it is recommended that visitor use surveys be conducted during and after alternative implementation to assess visitor satisfaction levels, access to recreation activities, public perception of the project, and expectations for recreational fishery recovery.

- Equipment storage and operations locations will be preapproved in consultation with Forest Service recreation specialists.

- Deposition of earth or rock material will be located only in approved locations as determined by the Ranger District.

- All slash and debris will be removed from construction sites unless permission and review has been provided to allow temporary storage or disposal on-site.

- When operationally practical, construction equipment operations will be minimized between the hours of 10:00 PM and 7:00 AM from April 30 through September 30 when it is audible in recreation use areas.

- When operationally practical, operations lighting will be diverted downward during all dark hours and be turned off during the night to minimize disturbance to recreation visitors and summer home owners during the regular use season.

- Visitor information will be established during alternative implementation to provide instructive material and explain procedures to the public to reduce user conflicts, inform visitors of areas "off-limits" and to educate people about the issues and solutions.

- ✓ Monitor the lake water after rotenone treatment to determine when it is safe to allow recreational water contact activities. Recreational water contact activities will not be permitted until monitoring results indicate that the lake water represents no risk to the public.

CULTURAL RESOURCES
Forest Plan S&Gs IV-29 (#1, 2); IV-93 (#4, 7).

OBJECTIVE: To protect historical and pre-historical resources.

ACTIONS:

- A qualified historian will be on-site during the removal of the road by the canal and dredging of the canal to document the condition of the headgate and concrete flume structure for the Diamond Lake Fisheries Management Canal. The documentation will be submitted to the State Historical Preservation Office.

- Construction will be stopped in order for cultural resource personnel to document the feature (headgate and concrete box structure), as it is exposed. If the headgate requires replacement, if possible the existing visible headwall will be attached to the new structure. Replacement work will be conducted according to the Secretary of the Interior's Standards for Rehabilitation for historic structures. An interpretation panel discussing the significance of the Diamond Lake Fishery Management Canal will be completed and established near the Diamond Lake Fishery Management Canal.

- Ground disturbing activities planned in areas where high probability of cultural resource occurrence is indicated will be monitored during and/or after project implementation. If cultural resources are discovered during project implementation, project implementation will cease until a determination on the find can be made by the Forest Archaeologist and appropriate measures to mitigate any adverse effects are undertaken.

BOTANY
BMP V-3, S & G's from the 2002 Integrated Weed Management Strategy, Forest Plan Amendment (Amendment #5 of the Umpqua LRMP).

OBJECTIVES: To maintain viable populations of native plant species.

ACTIONS:

- Terrestrial areas impacted by canal construction and other miscellaneous activities will be re-vegetated, using only local native plant species. Site specific planting prescriptions will be prepared by the District Botanist and plants and seed will be made available as necessary. This measure responds to the S&G's from the 2002 Integrated Weed Management Strategy, Forest Plan Amendment.

- In order to assess the impacts of the draw down on the wetland vegetation at the south shore of Diamond Lake and other sites to be determined in the future, a vegetation monitoring protocol will be established prior to and during implementation and for 5 years after the project is completed.

- The populations of Goblin's gold on the south shore will be monitored throughout the draw down period. If desiccation and mortality is observed then water will be brought to the root wad holes in buckets and poured into the holes to maintain humidity. At

least 10 of the 30 holes will be maintained with water throughout the draw down to reduce impacts.

- To prevent noxious weeds, use standard contract provisions that require all machinery and vehicles to be pressure washed and free of weed seed before coming on to the work site and before leaving the Forest. Avoid working in infested areas as much as possible. Educate work crews as to the locations of reed canary grass and inform them how to reduce the spread of this weed. This applies to all action alternatives. These measures respond to the S&G's from the 2002 Integrated Weed Management Strategy, Forest Plan Amendment

- Monitor the lake after the project to detect any new invasive aquatic plants to ensure that if there are invading species, they can be quickly treated. This measure responds to the S&G's from the 2002 Integrated Weed Management Strategy, Forest Plan Amendment.

- Monitor pre and post project to quantify aquatic macrophyte communities and potential impact to those communities.

PERMITS AND AUTHORIZATIONS

A number of permits, waivers, or special authorizations would be required to implement Alternatives 2, 3 and 5 and the connected actions proposed by the Diamond Lake Resort owners (Table 1). Alternative 4 would also require several special authorizations (Table 2).

Table 1. Required Permits/Authorization for Alternatives 2, 3 and 5 and Connected Actions.

Issuing Agency	Type of Permit/Authorization	Activity Requiring Permit/Authorization
US Forest Service	Pesticide-Use Proposal Form (FS-2100-2)	Application of rotenone (requires transport across and staging for application on National Forest system lands)

Issuing Agency	Type of Permit/Authorization	Activity Requiring Permit/Authorization
	Special Use Permit Modification	Connected actions – dredging and spoil disposal
	Area Closure (Title 36CFR, section 261.50(a)(b))	Lake closure during rotenone application to protect public health
	Memorandum of Understanding	Fish carcass processing on National Forest system lands
Oregon Department of Environmental Quality	National Pollutant Discharge Elimination System Permit (NPDES) and/or Section 401 Certification or other legally appropriate water quality permits	Application of rotenone Canal dredging and wetland expansion Lake draw down
Oregon Department of Fish and Wildlife	Commercial Fishing Authorization	Commercial harvest of fish before and after rotenone application
Oregon Fish and Wildlife Commission	Diamond Lake Management Plan Revision	Fish stocking following rotenone treatment
Oregon State Marine Board	Temporary Oregon Administrative Rule authorized by Director and/or Board	Full and partial lake closures for commercial fishing operations and rotenone application
Division of State Lands	Removal-Fill Permit	Canal dredging and wetland expansion Connected actions- dredging and spoil disposal
US Army Corps of Engineers	Removal-Fill Permit	Canal dredging and wetland expansion Connected actions- dredging and spoil disposal
Oregon Water Resources Department	Limited License for Drawdown & Lake Refill	Drawing down & refilling of Diamond Lake (requires negotiation with PacifiCorp
Oregon Department of Agriculture	Applicators Licenses	Application of rotenone (requires licensing of all personnel)

Table 2. Authorizations for Alternative 4.

Issuing Agency	Type of Authorization	Activity Requiring Authorization
US Forest Service	Memorandum of Understanding	Fish carcass processing on National Forest system lands
Oregon Department of Fish and Wildlife	Commercial Fishing Authorization	Commercial harvest of fish
Oregon Fish and Wildlife Commission	Diamond Lake Management Plan Revision	Changing Fish stocking strategy
Oregon State Marine Board	Temporary Oregon Administrative Rule authorized by Director and/or Board	Partial lake closure of lake for commercial fishing operations

SUMMARY AND COMPARISON OF ALTERANTIVES

Tables 3 and 4 compare and contrast the alternatives to each other as measured by how each alternative meets the purpose and need for action.

Table 3. Comparison of Alternatives at Meeting WATER QUALITY ELEMENT 1 of Purpose and Need.

Alternatives	Alternative 1 – No Action	Alternative 2 –Rotenone Put, Grow and Take Fishery	Alternative 3 – Rotenone Put and Take Fishery	Alternative 4 - Mechanical & Biological	Alternative 5- Modified Rotenone and Fish Stocking
Measure **Expected pH**	**Short-term** pH expected to remain high due to high phytoplankton primary production.	**Short-term** During the first 3 years after treatment, pH potentially would remain high and result in poor water quality.	**Short-term** During the first 3 years after treatment, pH potentially would remain high and result in poor water quality.	**Short-term** For 7 years pH would remain high. Near the end of the 7 years of treatment, pH potentially would decrease and result in improved water quality.	**Short-term** During the first 3 years after treatment, pH potentially would remain high and result in poor water quality.
(Qualitative Trend Analysis)	**Long-term** pH expected to remain high due to high phytoplankton primary production associated with high tui chub population.	**Long-term** After 3 years following treatment, pH expected to decrease and result in improved water quality At some unknown point in the future, if/when tui chub remain or are reintroduced and contingency plans fail, adverse impacts similar to current water quality problems would be expected to recur. However, if/when tui chub recur the likelihood of sustaining improvements in the water quality over time would be increased with annual implementation of the described contingency plan.	**Long-term** After 3 years following treatment, pH expected to decrease and result in improved water quality At some unknown point in the future, if/when tui chub remain or are reintroduced and contingency plans fail, adverse impacts similar to current water quality problems would be expected to recur. However, if/when tui chub recur the likelihood of sustaining improvements in the water quality over time would be increased with annual implementation of the described contingency plan.	**Long-term** After 7 years of treatment, pH would potentially be lower for a period of time resulting in improved in water quality. However, if annual mechanical removal fails or is stopped, the tui chub population would rebound and subsequent increases in pH and declines in water quality are expected. The likelihood of achieving or maintaining improvements in the water quality in the long-term would be increased with annual implementation of the described contingency plan over time.	**Long-term** After 3 years following treatment, pH expected to decrease and result in improved water quality At some unknown point in the future, if/when tui chub remain or are reintroduced and contingency plans fail, adverse impacts similar to current water quality problems would be expected to recur. However, if/when tui chub recur the likelihood of sustaining improvements in the water quality over time would be increased with annual implementation of the described contingency plan.
Measure **Phytoplankton Density and Primary Production**	**Short-term** Phytoplankton density would remain high and continue to degrade water quality.	**Short-term** During the first 3 years after treatment, phytoplankton density and primary production potentially would remain high and result in poor water quality.	**Short-term** During the first 3 years after treatment, phytoplankton density and primary production potentially would remain high and result in poor water quality.	**Short-term** For 7 years phytoplankton density would remain high. Near the end of 7 years of treatment, phytoplankton density expected to decrease and result in improved water quality.	**Short-term** During the first 3 years after treatment, phytoplankton density and primary production potentially would remain high and result in poor water quality.

Alternatives	Alternative 1 – No Action	Alternative 2 –Rotenone Put, Grow and Take Fishery	Alternative 3 – Rotenone Put and Take Fishery	Alternative 4 - Mechanical & Biological	Alternative 5- Modified Rotenone and Fish Stocking
(Qualitative Trend Analysis)	**Long-term** Phytoplankton density would remain high and continue to degrade water quality.	**Long-term** After 3 years following treatment, phytoplankton density and primary production expected to decrease and result in a noticeable improvement in water quality. At some unknown point in the future, if/when tui chub remain or are reintroduced and contingency plans fail, adverse impacts similar to current water quality problems would be expected to recur. However, if/when tui chub recur the likelihood of sustaining improvements in the water quality over time would be increased with annual implementation of the described contingency plan.	**Long-term** After 3 years following treatment, phytoplankton density and primary production expected to decrease and result in a noticeable improvement in water quality. At some unknown point in the future, if/when tui chub remain or are reintroduced and contingency plans fail, adverse impacts similar to current water quality problems would be expected to recur. However, if/when tui chub recur the likelihood of sustaining improvements in the water quality over time would be increased with annual implementation of the described contingency plan.	**Long-term** After 7 years of treatment, phytoplankton density and primary production expected to be lower for a period of time resulting in improved water quality over the existing condition. However, if annual mechanical removal fails or is stopped, the tui chub population would rebound and subsequent increases in pH and declines in water quality are expected. The likelihood of achieving or maintaining improvements in the water quality in the long-term would be increased with annual implementation of the described contingency plan over time.	**Long-term** After 3 years following treatment, phytoplankton density and primary production expected to decrease and result in a noticeable improvement in water quality. At some unknown point in the future, if/when tui chub remain or are reintroduced and contingency plans fail, adverse impacts similar to current water quality problems would be expected to recur. However, if/when tui chub recur the likelihood of sustaining improvements in the water quality over time would be increased with annual implementation of the described contingency plan.
Measure **Expected Blue-Green Algae Toxin Production**	**Short-term** Blue-green algae toxin production expected to continue. Annual lake closures expected.	**Short-term** During the first 3 years after treatment, blue-green algae toxin production potentially would remain high. Annual lake closures still expected.	**Short-term** During the first 3 years after treatment, blue-green algae toxin production potentially would remain high. Annual lake closures still expected.	**Short-term** For 7 years blue-green algae toxin production would remain high and annual lake closures are still expected. Near the end of 7 years of treatment, blue-green algae toxin production expected to decrease; severity of algae blooms would be reduced and annual lake closures not expected.	**Short-term** During the first 3 years after treatment, blue-green algae toxin production potentially would remain high. Annual lake closures still expected.

Alternatives	Alternative 1 – No Action	Alternative 2 –Rotenone Put, Grow and Take Fishery	Alternative 3 – Rotenone Put and Take Fishery	Alternative 4 - Mechanical & Biological	Alternative 5- Modified Rotenone and Fish Stocking
(Qualitative Trend Analysis)	**Long-term** Blue-green algae toxin production expected to continue. Annual lake closures expected.	**Long-term** After 3 years following treatment, blue-green algae toxin production expected to decrease. Although periodic lake closures are still possible, severity of algae blooms would be reduced and annual lake closures not expected. At some unknown point in the future, if/when tui chub remain or are reintroduced and contingency plans fail, adverse impacts similar to current water quality problems would be expected to recur and annual lake closures would again be expected However, if/when tui chub recur the likelihood of sustaining improvements in the water quality over time would be increased with annual implementation of the described contingency plan.	**Long-term** After 3 years following treatment, blue-green algae toxin production expected to decrease. Although periodic lake closures are still possible, severity of algae blooms would be reduced and annual lake closures not expected. At some unknown point in the future, if/when tui chub remain or are reintroduced and contingency plans fail, adverse impacts similar to current water quality problems would be expected to recur and annual lake closures would again be expected However, if/when tui chub recur the likelihood of sustaining improvements in the water quality over time would be increased with annual implementation of the described contingency plan.	**Long-term** After 7 years of treatment, blue-green algae toxin production expected to be lower for a period of time. However, if annual mechanical removal fails or is stopped, the tui chub population would rebound and annual lake closures would again be expected. The likelihood of achieving or maintaining improvements in the water quality in the long-term would be increased with annual implementation of the described contingency plan over time.	**Long-term** After 3 years following treatment, blue-green algae toxin production expected to decrease. Although periodic lake closures are still possible, severity of algae blooms would be reduced and annual lake closures not expected. At some unknown point in the future, if/when tui chub remain or are reintroduced and contingency plans fail, adverse impacts similar to current water quality problems would be expected to recur and annual lake closures would again be expected However, if/when tui chub recur the likelihood of sustaining improvements in the water quality over time would be increased with annual implementation of the described contingency plan.

Table 4. Comparison of Alternatives at Meeting RECREATIONAL FISHERY ELEMENT 2 of Purpose and Need.

Alternatives	Alternative 1 – No Action	Alternative 2* - Rotenone Put, Grow and Take Fishery	Alternative 3* - Rotenone Put and Take Fishery	Alternative 4** - Mechanical & Biological	Alternative 5*- Modified Rotenone and Fish Stocking
Measure	**Short-term**	**Short-term**	**Short-term**	**Short-term**	**Short-term**
Expected Tui Chub Populations (Qualitative Trend Analysis)	Tui chub populations would remain high, limited only by available food and habitat resources.	Based upon the past rotenone treatment, tui chub would likely be eradicated from Diamond Lake.	Based upon the past rotenone treatment, tui chub would likely be eradicated from Diamond Lake.	Tui chub populations may decrease as a result of commercial harvest and biological controls.	Based upon the past rotenone treatment, tui chub would likely be eradicated from Diamond Lake.
	Long-Term	**Long-Term**	**Long -Term**	**Long-Term**	**Long -Term**
	Tui chub populations would remain high, limited only by available food and habitat resources.	Based upon the past rotenone treatment, tui chub would likely be eradicated from Diamond Lake and remain absent for an undetermined period of time. At some unknown point in the future, if/when tui chub remain or are reintroduced and preventative contingency plans fail, exponential tui chub population growth similar to that seen in the past would be expected to recur. However, if/when tui chub recur the likelihood of preventing exponential population growth over time would be increased with annual implementation of the described contingency plan.	Based upon the past rotenone treatment, tui chub would likely be eradicated from Diamond Lake and remain absent for an undetermined period of time. At some unknown point in the future, if/when tui chub remain or are reintroduced and preventative contingency plans fail, exponential tui chub population growth similar to that seen in the past would be expected to recur. However, if/when tui chub recur the likelihood of preventing exponential population growth over time would be increased with annual implementation of the described contingency plan.	Tui chub populations may stabilize at a lower level than that seen under Alternative 1 as a result of mechanical removal and biological controls. The size and productivity of remaining chub would likely increase substantially over time as remaining fish compensate for this by increasing body size and egg production. If mechanical and biological controls fail, exponential tui chub population growth similar to that seen in the past would be expected to recur. The likelihood of limiting exponential population growth over time would be increased with annual implementation of the described contingency plan.	Based upon the past rotenone treatment, tui chub would likely be eradicated from Diamond Lake and remain absent for an undetermined period of time. At some unknown point in the future, if/when tui chub remain or are reintroduced and preventative contingency plans fail, exponential tui chub population growth similar to that seen in the past would be expected to recur. However, if/when tui chub recur the likelihood of preventing exponential population growth over time would be increased with annual implementation of the described contingency plan.

Alternatives	Alternative 1 – No Action	Alternative 2* – Rotenone Put, Grow and Take Fishery	Alternative 3* – Rotenone Put and Take Fishery	Alternative 4** - Mechanical & Biological	Alternative 5*- Modified Rotenone and Fish Stocking
Measure **Expected Edible Zooplankton and Benthic Invertebrate Numbers** (Qualitative Trend Analysis)	**Short-Term** Continued high negative impacts to numbers of edible zooplankton and benthic invertebrates due to high predation by tui chub, and continued poor water quality conditions.	**Short-Term** High negative impacts to zooplankton and benthic invertebrates immediately following rotenone treatment. Rapid (within 1 year) recovery of edible zooplankton and benthic invertebrates due to lack of intense predation by tui chub, and gradually improving water quality conditions.	**Short-Term** High negative impacts to zooplankton and benthic invertebrates immediately following rotenone treatment. Rapid (within 1 year) recovery of edible zooplankton and benthic invertebrates due to lack of intense predation by tui chub, and gradually improving water quality conditions.	**Short-Term** Continued moderate to high negative impacts to numbers of edible zooplankton and benthic invertebrates due to moderate/high predation by tui chub, and continued poor water quality conditions.	**Short-Term** High negative impacts to zooplankton and benthic invertebrates immediately following rotenone treatment. Rapid (within 1 year) recovery of edible zooplankton and benthic invertebrates due to lack of intense predation by tui chub, and gradually improving water quality conditions.
	Long-Term Continued high negative impacts to numbers of edible zooplankton and benthic invertebrates due to high predation by tui chub, and continued poor water quality conditions.	**Long-Term** Relatively low impacts to edible zooplankton and benthic invertebrates due to low levels of predation from fingerling and adult rainbow trout only. In addition, continued water quality improvements allow expansion and recovery of benthic invertebrate populations.	**Long-Term** Very low impacts to edible zooplankton and benthic invertebrates due to a virtual lack of predation from domesticated rainbow trout. In addition, continued water quality improvements allow expansion and recovery of benthic invertebrate populations.	**Long-Term** Continued moderate impacts to numbers of edible zooplankton and benthic invertebrates due to moderate predation by reduced tui chub populations and occasional poor water quality conditions.	**Long-Term** Relatively low impacts to edible zooplankton and benthic invertebrates due to low levels of predation from fingerling and adult rainbow trout only. In addition, continued water quality improvements allow expansion and recovery of benthic invertebrate populations.
Measure **Estimated Annual Angler Catch***** (Fish/year)	Annual catch estimated to be 10,000 fish/year (2008-2011).	Annual catch estimated to be between 100,000-200,000 fish/year (2008-2011).	Annual catch estimated to be between 80,000-160,000 fish/year (2008-2011).	Annual catch estimated to be between 55,000-72,000 fish/year (2008-2011).	Annual catch estimated to be between 100,000-200,000 fish/year (2008-2011).
Measure **Trout body condition** (Qualitative Assessment)	Stocked legal-sized fish would continue to lose body mass due to lack of food resources.	Stocked fingerlings would grow quickly due to utilization of the abundant food resources (i.e. zooplankton and benthic organisms).	Stocked legal-sized fish would continue to lose body mass due to their highly domesticated nature and lack of tendency to feed upon available food resources.	An unknown portion of the stocked larger-sized fish would likely gain body mass as they prey upon chub populations.	Stocked legal-sized fish would continue to lose body mass due to lack of food resources.

* It is also acknowledged that under Alternatives 2, 3, and 5, at some unknown point in the future, if tui chub remain or if/when they are reintroduced and contingency plans fail, negative impacts to the recreational fishery similar to the current condition would again occur. Under this scenario, the likelihood of sustaining improvements in the recreational fishery in the long-term may be increased with annual implementation of the described contingency plan.

** The likelihood of achieving or maintaining improvements in recreational fishery in the long-term under this alternative may be increased with annual implementation of the described contingency plan.

*** Estimated annual angler catch values were developed by the Oregon Department of Fish and Wildlife, 2004.

Tables 5-8 compare and contrast the alternatives to each other as measured by how each alternative responds to the significant issues.

Table 5. Comparison of Alternatives at Responding to FISH STOCKING ISSUE 1.

Alternatives	Alternative 1 – No Action	Alternative 2 –Rotenone Put, Grow and Take Fishery	Alternative 3 – Rotenone Put and Take Fishery	Alternative 4 - Mechanical & Biological	Alternative 5- Modified Rotenone and Fish Stocking
Indicator **Fish Stocking Management Strategy**	Experimental Fish Stocking Program in the short-term, followed by stocking of 24,000 legal-sized fish annually in the long-term (small put-and-take fishery).	Basic Yield Alternative, using ecological indices to determine appropriate numbers of fish to stock. (moderate to large put-grow-and-take fishery).	Intensive Use Alternative, large numbers of legal-sized fish would be stocked annually (large put-and-take fishery). Minimizes potential impacts of fishery on water quality.	Featured Species or Trophy Fish Alternative, large numbers of legal or trophy sized fish would be stocked annually in combination with smaller number of larger predacious fish (moderate to large put and take fishery).	Basic Yield Alternative, using ecological indices to determine appropriate numbers of fish to stock. (moderate to large put-grow-and-take fishery).
Indicator **Fish Species Mix Selected for Use**	Continued experimentation with legal sized Eagle Lake rainbow trout, brown trout, and/or spring Chinook salmon in the short-term. Small numbers of legal sized Eagle Lake rainbow trout in long-term.	Fishwich or Oak Springs stock rainbow trout fingerlings, and smaller numbers of larger sized Eagle Lake rainbow trout, brown trout, or spring Chinook salmon.	Trout Lodge stock of rainbow trout, with smaller numbers of larger sized Eagle Lake rainbow trout, brown trout, or spring Chinook salmon. Represents a different stocking strategy than Basic Yield.	Eagle Lake rainbow trout (Featured Species Alternative) Or Brown trout or Kamloops Trout (Trophy Fish Alternative). Represents a different strategy than Basic Yield with a focus on larger numbers of different species of predators.	Fishwich or Oak Springs stock rainbow trout fingerlings, and smaller numbers of larger sized Eagle Lake rainbow trout, brown trout, or spring Chinook salmon.

Table 6. Comparison of Alternatives at Responding to NON-TARGET SPECIES ISSUE 2.

Alternatives	Alternative 1 – No Action	Alternative 2 –Rotenone Put, Grow and Take Fishery	Alternative 3 – Rotenone Put and Take Fishery	Alternative 4 - Mechanical & Biological	Alternative 5- Modified Rotenone and Fish Stocking
Indicator **Effects to Bald Eagles**	**"Likely to Adversely Affect"** through perpetuation of eagle exposure to algal toxins.	**"Likely to Adversely Affect"** through substantial temporary reductions in prey base and potential effects on reproductive success.	**"Likely to Adversely Affect"** through substantial temporary reductions in prey base and potential effects on reproductive success.	**"May Affect, But Not Likely to Adversely Affect"** through insignificant reductions in prey base.	**"Likely to Adversely Affect"** through substantial temporary reductions in prey base and potential effects on reproductive success.
Indicator **Effects to Coho Salmon**	**"May Affect, But Not Likely to Adversely Affect"**	**"May Affect, But Not Likely to Adversely Affect"**	**"May Affect, But Not Likely to Adversely Affect"**	**"May Affect, But Not Likely to Adversely Affect"**	**"May Affect, But Not Likely to Adversely Affect"**

Table 7. Comparison of Alternatives at Responding to WATER QUALITY ISSUE 3.

Alternatives	Alternative 1 – No Action	Alternative 2 –Rotenone with Put Grow and Take Fishery	Alternative 3 – Rotenone with Put and Take Fishery	Alternative 4 - Mechanical & Biological	Alternative 5 – Modified Rotenone and Fish Stocking
Indicator **Expected summer pH** **DIAMOND LAKE**	**Short-term** pH expected to remain high due to high phytoplankton primary production.	**Short-term** During the first 3 years after treatment, pH potentially would remain high and result in poor water quality.	**Short-term** During the first 3 years after treatment, pH potentially would remain high and result in poor water quality.	**Short-term** For 7 years pH would remain high. Near the end of the 7 years of treatment, pH potentially would decrease and result in improved water quality.	**Short-term** During the first 3 years after treatment, pH potentially would remain high and result in poor water quality.
	Long-term pH expected to remain high due to high phytoplankton primary production associated with high tui chub population.	**Long-term** After 3 years following treatment, pH expected to decrease and result in improved water quality. At some unknown point in the future, if/when tui chub remain or are reintroduced and contingency plans fail, adverse impacts similar to current water quality problems would be expected to recur. However, if/when tui chub recur the likelihood of sustaining improvements in the water quality over time would be increased with annual implementation of the described contingency plan.	**Long-term** After 3 years following treatment, pH expected to decrease and result in improved water quality. At some unknown point in the future, if/when tui chub remain or are reintroduced and contingency plans fail, adverse impacts similar to current water quality problems would be expected to recur. However, if/when tui chub recur the likelihood of sustaining improvements in the water quality over time would be increased with annual implementation of the described contingency plan.	**Long-term** After 7 years of treatment, pH would potentially be lower for a period of time resulting in improved in water quality. However, if annual mechanical removal fails or is stopped, the tui chub population would rebound and subsequent increases in pH and declines in water quality are expected. The likelihood of achieving or maintaining improvements in the water quality in the long-term would be increased with annual implementation of the described contingency plan over time.	**Long-term** After 3 years following treatment, pH expected to decrease and result in improved water quality. At some unknown point in the future, if/when tui chub remain or are reintroduced and contingency plans fail, adverse impacts similar to current water quality problems would be expected to recur. However, if/when tui chub recur the likelihood of sustaining improvements in the water quality over time would be increased with annual implementation of the described contingency plan.
Indicator **Expected summer pH** **LAKE CREEK**	**Short-term** pH in upper reaches would remain high and continue to lower water quality but in downstream reaches pH would continue to be lower.	**Short-term** From years 1-3 after treatment, pH in upper reaches expected to remain high and continue to lower water quality but downstream reaches pH would continue to be lower.	**Short-term** From years 1-3 after treatment, pH in upper reaches expected to remain high and continue to lower water quality but downstream reaches pH would continue to be lower.	**Short-term** From years 1-7 after treatment, pH in upper reaches expected to slightly reduce over time while downstream would remain unchanged.	**Short-term** From years 1-3 after treatment, pH in upper reaches expected to remain high and continue to lower water quality but downstream reaches pH would continue to be lower.
	Long-term pH in upper reaches would remain high and continue to lower water quality but in downstream reaches pH	**Long-term** After 3 years, pH in upper reaches expected to decrease and result in noticeable improvement in	**Long-term** After 3 years, pH in upper reaches expected to decrease and result in noticeable improvement in	**Long-term** After 7 years, pH in upper reaches expected to decrease and result in noticeable improvement in	**Long-term** After 3 years, pH in upper reaches expected to decrease and result in noticeable improvement in

Alternatives	Alternative 1 – No Action	Alternative 2 –Rotenone with Put Grow and Take Fishery	Alternative 3 – Rotenone with Put and Take Fishery	Alternative 4 - Mechanical & Biological	Alternative 5 – Modified Rotenone and Fish Stocking
	would continue to be lower.	water quality over time while downstream would remain lower and unchanged. At some unknown point in the future, if/when tui chub remain or are reintroduced and contingency plans fail, adverse impacts similar to current water quality problems would be expected to recur. However, if/when tui chub recur the likelihood of sustaining improvements in the water quality over time would be increased with annual implementation of the described contingency plan.	water quality over time while downstream would remain lower and unchanged. At some unknown point in the future, if/when tui chub remain or are reintroduced and contingency plans fail, adverse impacts similar to current water quality problems would be expected to recur. However, if/when tui chub recur the likelihood of sustaining improvements in the water quality over time would be increased with annual implementation of the described contingency plan.	water quality while downstream would remain lower and unchanged. However, if annual mechanical removal fails or is stopped, the tui chub population would rebound and subsequent increases in pH and declines in water quality are expected. The likelihood of achieving or maintaining improvements in the water quality in the long-term would be increased with annual implementation of the described contingency plan over time.	water quality over time while downstream would remain lower and unchanged. At some unknown point in the future, if/when tui chub remain or are reintroduced and contingency plans fail, adverse impacts similar to current water quality problems would be expected to recur. However, if/when tui chub recur the likelihood of sustaining improvements in the water quality over time would be increased with annual implementation of the described contingency plan.
Indicator **Expected summer pH** **LEMOLO RESERVOIR**	**Short-term** pH would remain high and continue to degrade water quality near the surface with nutrient contribution from Diamond Lake and delivered by Lake Creek.	**Short-term** From years 1-3 after treatment, pH would remain high and continue to degrade water quality near the surface with nutrient contribution from Diamond Lake and delivered by Lake Creek.	**Short-term** From years 1-3 after treatment, pH would remain high and continue to degrade water quality near the surface with nutrient contribution from Diamond Lake and delivered by Lake Creek.	**Short-term** From years 1-7 after treatment, pH near the surface expected to remain high and degrade water quality with nutrient contribution from Diamond Lake and delivered by Lake Creek, but showing slight improvement in the latter years.	**Short-term** From years 1-3 after treatment, pH would remain high and continue to degrade water quality near the surface with nutrient contribution from Diamond Lake and delivered by Lake Creek.
	Long-term pH would remain high and continue to degrade water quality near the surface with nutrient contribution from Diamond Lake and delivered by Lake Creek.	**Long-term** After 3 years, pH expected to decrease near the surface with reduced nutrient from Diamond Lake and result in noticeable improvement in water quality over time. At some unknown point in the future, if/when tui chub remain or are reintroduced and contingency plans fail, adverse impacts similar to current water quality	**Long-term** After 3 years, pH expected to decrease near the surface with reduced nutrient from Diamond Lake and result in noticeable improvement in water quality over time. At some unknown point in the future, if/when tui chub remain or are reintroduced and contingency plans fail, adverse impacts similar to current water quality	**Long-term** After 7 years, pH expected to decrease near the surface with reduced nutrient from Diamond Lake and result in noticeable improvement in water quality. However, if annual mechanical removal fails or is stopped, the tui chub population would rebound and subsequent increases in pH and declines in water	**Long-term** After 3 years, pH expected to decrease near the surface with reduced nutrient from Diamond Lake and result in noticeable improvement in water quality over time. At some unknown point in the future, if/when tui chub remain or are reintroduced and contingency plans fail, adverse impacts similar to current water quality

Alternatives	Alternative 1 – No Action	Alternative 2 –Rotenone with Put Grow and Take Fishery	Alternative 3 – Rotenone with Put and Take Fishery	Alternative 4 - Mechanical & Biological	Alternative 5 – Modified Rotenone and Fish Stocking
		problems would be expected to recur. However, if/when tui chub recur the likelihood of sustaining improvements in the water quality over time would be increased with annual implementation of the described contingency plan.	problems would be expected to recur. However, if/when tui chub recur the likelihood of sustaining improvements in the water quality over time would be increased with annual implementation of the described contingency plan.	quality are expected. The likelihood of achieving or maintaining improvements in the water quality in the long-term would be increased with annual implementation of the described contingency plan over time.	problems would be expected to recur. However, if/when tui chub recur the likelihood of sustaining improvements in the water quality over time would be increased with annual implementation of the described contingency plan.
Indicator **Average Zooplankton Body Size**	**Short-Term** Continued high negative impacts to zooplankton body size due to high predation by tui chub. Results in an ecological condition that continues degraded water quality.	**Short-Term** High negative short-term impacts to zooplankton due to rotenone treatment. Results in an ecological condition that temporarily continues degraded water quality.	**Short-Term** High negative short-term impacts to zooplankton due to rotenone treatment. Results in an ecological condition that temporarily continues degraded water quality.	**Short-Term** Continued moderate to high short-term negative impacts to zooplankton size due to continued moderate to high predation levels. Results in an ecological condition that continues degraded water quality.	**Short-Term** High negative short-term impacts to zooplankton due to rotenone treatment. Results in an ecological condition that temporarily continues degraded water quality
	Long-term Continued high negative impacts to zooplankton body size due to high predation by tui chub. Results in an ecological condition that continues degraded water quality.	**Long-term*** Moderate to High mid and long-term beneficial impacts to zooplankton size due to lack of intense tui chub predation, and only low to moderate predation by trout fingerlings. Results in an ecological condition that supports improved water quality.	**Long-term*** High mid and long-term beneficial impacts to zooplankton size due to lack of intense tui chub predation, and low or no predation by stocked domesticated trout. Results in an ecological condition that supports improved water quality.	**Long-term**** Some improvements expected following the mechanical and biological control of tui chub populations. Continued moderate impacts to zooplankton body size due to moderate predation by reduced tui chub populations Results in an ecological condition with uncertain outcomes for water quality.	**Long-term*** Moderate to High mid and long-term beneficial impacts to zooplankton size due to lack of intense tui chub predation, and only low to moderate predation by trout fingerlings. Results in an ecological condition that supports improved water quality.
Indicator **Risk of Well Water Contamination by Toxins**	**Short Term** No rotenone risks. No meaningful algal toxin risks.	**Short Term** Rotenone risks low to none with mitigation. No meaningful algal toxin risks.	**Short Term** Rotenone risks low to none with mitigation. No meaningful algal toxin risks.	**Short Term** No rotenone risks. No meaningful algal toxin risks.	**Short Term** No rotenone risks. No meaningful algal toxin risks.
	Long Term No rotenone risks. No meaningful algal toxin risks.	**Long Term** No rotenone risks. No meaningful algal toxin risks.	**Long Term** No rotenone risks. No meaningful algal toxin risks.	**Long Term** No rotenone risks. No meaningful algal toxin risks.	**Long Term** No rotenone risks. No meaningful algal toxin risks.

* It is also acknowledged that under Alternatives 2, 3, and 5, at some unknown point in the future, if tui chub remain or if/when they are reintroduced and contingency plans fail, negative impacts to zooplankton populations would again occur. Under this scenario, the likelihood of sustaining improvements to zooplankton in the long-term may be increased with annual implementation of the described contingency plan.
** The likelihood of achieving or maintaining improvements in zooplankton populations in the long-term under this alternative may be increased with annual implementation of the described contingency plan.
Note: None of the Alternatives would result in pH changes in the North Umpqua River downstream of Lemolo Reservoir. Three additional indicators for the water quality issue are summarized in Table 4 (table for WQ Element 1).

Table 8. Comparison of Alternatives at Responding to WETLAND ECOLOGY ISSUE 4.

Alternatives	Alternative 1 – No Action	Alternative 2 –Rotenone Put, Grow and Take Fishery	Alternative 3 – Rotenone Put and Take Fishery	Alternative 4 - Mechanical & Biological	Alternative 5- Modified Rotenone and Fish Stocking
Indicator **Effects to rare plant communities in wetland**	**Short-term** No Effect	**Short-term** Likely Negative Effects	**Short-term** Likely Negative Effects	**Short-term** No Effect	**Short-term** Likely Negative Effects
	Long-term No Effect	**Long-term** Minimal Risk of Effects	**Long-term** Minimal Risk of Effects	**Long-term** No Effect	**Long-term** Minimal Risk of Effects
Indicator **Acres of wetlands temporarily dewatered**	**Short-term** 0	**Short-term** 135	**Short-term** 135	**Short-term** 0	**Short-term** 135
	Long-term 0	**Long-term** 0	**Long-term** 0	**Long-term** 0	**Long-term** 0
Indicator **Stream Channel Morphology** ***Lake Creek***	**Short-term** No effect on channel morphology because streamflow is not changed.	**Short-term** From years 1-3, during the draw down phase, temporary bank erosion at three specific sites and sorting of finer substrate and improving pool depth at large wood sites under continuous bankfull flow or higher winter or spring flows.	**Short-term** From years 1-3, during the draw down phase, temporary bank erosion at three specific sites and sorting of finer substrate and improving pool depth at large wood sites under continuous bankfull flow or higher winter or spring flows.	**Short-term** No effect on channel morphology because streamflow is not changed.	**Short-term** From years 1-3, during the draw down phase, temporary bank erosion at three specific sites and sorting of finer substrate and improving pool depth at large wood sites under continuous bankfull flow or higher winter or spring flows.
	Long-term No effect on channel morphology because streamflow is not changed.	**Long-term** After 3 years, no effect on channel morphology because streamflow returns to the natural flow regime.	**Long-term** After 3 years, no effect on channel morphology because streamflow returns to the natural flow regime.	**Long-term** No effect on channel morphology because streamflow is not changed.	**Long-term** After 3 years, no effect on channel morphology because streamflow returns to the natural flow regime.

Alternatives	Alternative 1 – No Action	Alternative 2 –Rotenone Put, Grow and Take Fishery	Alternative 3 – Rotenone Put and Take Fishery	Alternative 4 - Mechanical & Biological	Alternative 5- Modified Rotenone and Fish Stocking
Indicator **Stream Channel Morphology** ***North Umpqua River***	**Short-term** No effect on channel morphology because streamflow is not changed.	**Short-term** From years 1-3, during the initial months of the draw down phase, additional flow released to equal bankfull flow would only be potentially detectable immediately below Lemolo Reservoir but no effect on channel morphology would be expected because of the limited flow.	**Short-term** From years 1-3, during the initial months of the draw down phase, additional flow released to equal bankfull flow would only be potentially detectable immediately below Lemolo Reservoir but no effect on channel morphology would be expected because of the limited amount.	**Short-term** No effect on channel morphology because streamflow is not changed.	**Short-term** From years 1-3, during the initial months of the draw down phase, additional flow released to equal bankfull flow would only be potentially detectable immediately below Lemolo Reservoir but no effect on channel morphology would be expected because of the limited amount.
	Long-term No effect on channel morphology because streamflow is not changed.	**Long-term** After 3 years, no effect on channel morphology because streamflow returns to natural flow.	**Long-term** After 3 years, no effect on channel morphology because streamflow returns to natural flow.	**Long-term** No effect on channel morphology because streamflow is not changed.	**Long-term** After 3 years, no effect on channel morphology because streamflow returns to natural flow.

ALTERNATIVES CONSIDERED, BUT ELIMINATED FROM DETAILED STUDY

Internal and external scoping prompted the exploration of an extensive number of alternatives that were considered, but eliminated from detailed study. The Diamond Lake Restoration Project Scoping Summary and 07/22- 23/03 IDT meeting notes, in combination, represent a comprehensive list of alternatives considered and rationale for elimination from detailed study. These documents are incorporated by reference. A panel of lake experts (and members of the public) joined IDT members on July 22 and 23 to recommend options, review alternatives and to provide rationale for any alternatives that were not considered feasible. The following summarizes all of the alternatives that were considered in response to scoping, but were eliminated from detailed study:

A. An alternative was considered that contained uniquely federal goals and plans for the management of Diamond Lake. This alternative was eliminated from detailed study because there are multiple non-federal agencies that have jurisdictional authority over some aspects of the management of Diamond Lake.

B. An alternative was considered that would have as a goal, the return of Diamond Lake to a fishless condition. Under this alternative, following a chemical treatment to remove tui chub, ODFW would not stock Diamond Lake with fish. This alternative was eliminated from detailed study because: (1) keeping Diamond Lake fishless is considered infeasible. Based on its 93 year history as a popular fishing lake, it is expected that members of the public would plant fish in the lake, if ODFW did not; and (2) the decision to manage Diamond Lake to provide a recreational fishery was made under prior legislation as documented in both the Oregon Administrative Rules and the 1990 LRMP.

C. An alternative was considered that would stock Diamond Lake with predacious fish as the primary means of controlling the tui chub population. This alternative was eliminated from detailed study because it would not meet the purpose and need. Due to the extremely large existing tui chub population and the chub's high reproductive capacity, it is unreasonable to assume that predacious fish would be able to effectively limit the chub's population.

D. An alternative was considered that would utilize a bounty on chubs as the primary means to reduce the tui chub population. This alternative was eliminated from detailed study because it is not considered feasible at meeting the purpose and need due to the extremely large existing tui chub population and their high reproductive capacity. However, this method was incorporated into Alternative 4 as a possible supplemental tool for removing tui chub while informing the public about the chub's role in the declining health of the lake.

E. Alternatives that considered stocking Diamond Lake with the following fish species were considered: whipers, catfish, largemouth bass, adult hatchery steelhead, juvenile steelhead, Crane Prairie rainbow trout, coastal cutthroat trout, northern pike, and walleye. These alternatives were eliminated from detailed study because ODFW determined they represented unacceptable risks to downstream fish populations. See

Appendix 2 of the Diamond Lake Restoration Scoping Summary for a species specific rationale.

F. An alternative was considered that would chemically kill (herbicides) or mechanically harvest aquatic macrophytes to destroy chub habitat and thus control the chub population. This alternative was eliminated from detailed study because: (1) a complete removal of macrophytes would be expected to have a negative effect on water quality and thus would not meet the purpose and need; and (2) mechanical harvest of macrophytes is considered logistically infeasible due to the limitations of harvest equipment and the depth of macrophytes in Diamond Lake.

G. An alternative was considered that would use macrophagus fish (fish that eat macrophytes), grass carp, to reduce the available chub spawning habitat in Diamond Lake. This alternative was eliminated from detailed study because: grass carp are a very prolific non-native species that pose an unacceptable risk to native fish in the North Umpqua River and could have a negative impact on water quality. Thus, this alternative would not meet the purpose and need.

H. An alternative was considered that would establish checkpoints to inspect for chub, impose fines for violations, and set up toll booths on Highway 138 as a means of preventing the reintroduction of tui chub in Diamond Lake. This alternative was eliminated from detailed study because constructing and staffing toll booths on Highway 138 is considered to be economically and logistically infeasible.

I. An alternative was considered that would poison chub eggs as a means to reduce the tui chub population. This alternative was eliminated from detailed study because data is inconclusive and speculative regarding the effectiveness of known poisons (that have acceptable levels of impacts to water quality) at killing eggs.

J. An alternative was considered that would remove the dam/weir on Lake Creek as means of improving water quality in Diamond Lake. This alternative was eliminated from detailed study because the amount of water that is impounded by the weir during the summer months is inconsequential relative to the hydraulic residence time[38] of the lake. Thus, this alternative would not be effective at improving water quality and would not meet the purpose and need.

K. An alternative was considered that would induce dissolved oxygen depletion in Diamond Lake to kill the tui chub. This alternative was eliminated from detailed study because: it is technologically infeasible to create and sustain anoxic[39] conditions sufficient to eradicate the tui chub due to the continuous addition of oxygen from macrophytes, the atmosphere, groundwater, and inlet streams; and it would have a negative impact on water quality and thus would not meet the purpose and need.

[38] Hydraulic residence time refers to the time it takes water to move into, through, and out of a lake. Approximately 1.6 years is the hydraulic residence time of Diamond Lake

[39] Anoxic means greatly deficient or without oxygen.

L. An alternative was considered that would add chemicals such as alum/ferric chloride to the lake to reduce available Phosphorous and thus limit the development of blue-green algae blooms. This alternative was eliminated from detailed study because it is would not be effective at meeting water quality goals. Treatment would prevent or limit the development of an algae bloom for one season, but would have to be repeated annually because the continuous inflow of Phosphorous from natural sources is too high. This alternative would not meet the purpose and need.

M. An alternative was considered that would use an algicide to address algae blooms at Diamond Lake. This alternative was eliminated from detailed study because it would: require repeated treatments perhaps twice a season; be toxic to zooplankton exacerbating the lake's existing "food chain" imbalance; and with long-term use cause decreases in water quality. This alternative would result in unreasonable environmental harm and would not meet the purpose and need.

N. An alternative was considered that would add ammonium nitrate to modify the Nitrogen:Phosphorous ratio in Diamond Lake as a means of eliminating toxic blue-green algae. This alternative was eliminated from detailed study because it would: negatively impact water quality goals for pH in the lake; negatively impact water quality in the North Umpqua River system through the release of more organic nitrogen; require annual treatments; and thus would not meet the purpose and need.

O. An alternative that would use aeration as a means of reducing toxic algae blooms was considered and explored through field investigations, literature review, and discussions with aeration system suppliers. The following summary of the technique and its utility for this project was provided by the principle investigator, Joe Eilers (Pers. comm. 2003):

> Aeration is a technique used to address water quality problems associated with eutrophication and organic pollution. Air is pumped into the lake to provide additional oxygen to the system and thereby maintain adequate oxygen in the water to promote aerobic decomposition and to provide oxygen for aquatic organisms. Aeration has been used to minimize water quality problems associated with algal blooms for a number of years (Cooke et al. 1993). The aeration of a lake with an anaerobic hypolimnion can decrease the rate of internal loading associated with dissolution of PO_4 from the sediments. This decreases the availability of nutrients to the phytoplankton. Aeration has particular benefits in lakes with cyanobacteria blooms by increasing the degree of physical mixing. Cyanobacteria are favored in calm conditions and increased physical mixing causes cyanobacteria to be mixed deeper in the lake, thus depriving them of adequate light for maximum photosynthesis.
>
> Two pilot projects were conducted in Diamond Lake to assess the viability of aeration to control the water quality problems associated with the *Anabaena* blooms. The first project, conducted in 2002, involved testing a single aeration disk (Air Diffusion Systems) in the deepest area of the lake and in a shallow-water application. Both site tests showed that aeration could be applied to Diamond Lake without disturbing the flocculent sediments. A more comprehensive test was conducted in August 2003 that involved placement of three aeration disks in the deep area of the lake and operating

these continuously for one week. The results indicated that the degree of physical mixing achieved with the aeration disks was limited to a very small area. Consequently, the number of aeration disks that would be required to achieve adequate mixing of the lake was judged to be prohibitive for the intended application.

An aeration supplier estimated that a properly sized aeration system for Diamond Lake would include eight, 10 horsepower compressors connected to 80 aeration disks by an unquantified extent of feeder tubing. The approximate cost for installation of these components was $350,000 - $400,000. Other costs associated with the system are: construction of approximately four small buildings to house the compressors and reduce noise levels; potential economic and ecological costs associated with installing three phase electric lines to power the compressors; and approximately $28,800 per year for electricity to operate the system on a year round basis.

This alternative was eliminated from detailed study because it would not meet the purpose and need. Although a properly sized aeration system could improve water quality, it would not address the need for an improved recreational fishery and would only address the symptoms rather than the primary source (tui chub) of the water quality problem at Diamond Lake. Additionally, this alternative is considered technologically impractical with unacceptable visual impacts.

P. An alternative was considered that would focus on reducing the external sources of nutrients (i.e. from septic systems) as the primary means of improving water quality. This alternative was eliminated from detailed study because the external nutrient load is inconsequential relative to inputs from natural sources; thus, it would not be effective at improving water quality and would not meet the purpose and need.

Q. An alternative was considered that would use multiple, annual lake draw downs to kill chub eggs by dewatering the spawning habitat. This alternative was eliminated from detailed study because it is technologically infeasible to time the draw downs to precisely overlap the six- day chub incubation period and to maintain Lake Creek at bankfull volumes for extended time periods annually.

R. An alternative was considered that would utilize only electricity (electro shocking) to kill tui chub in Diamond. This alternative was eliminated from detailed study because it is considered logistically impractical and ineffective at killing small fish in a large lake. However, this method was incorporated into Alternative 4.

S. An alternative was considered that would utilize electricity to superheat the lake as a means of killing the chub. This alternative was eliminated from detailed study because it is considered logistically impractical and would require diversion of cold water inputs (Silent and Short Creeks) into Diamond Lake.

T. Multiple alternatives that would completely drain the lake as a means of killing chub were considered in consultation with an engineering company. All were eliminated from detailed study. The following briefly summarizes these alternatives and provides rationale for their elimination:

- Draining Diamond Lake would be accomplished by microtunneling underneath the lake and installing a permanent drain into the deepest part of the lake. A pipe would extend 3,000 feet to the north into the Lake Creek drainage.
    - This alternative was eliminated due to high cost (approximately 41 million dollars) and risk of project failure. Tunnel construction through bedrock is extremely difficult and the potential for equipment damage is high. This alternative is considered technologically and economically infeasible.

- Draining Diamond Lake would be accomplished by installing a siphoning system that drains into Lake Creek at a bankfull discharge rate (110 cfs).
    - This alternative was eliminated because it would take approximately 23 months to drain the lake at this discharge rate. The environmental impacts of maintaining Lake Creek at bankfull conditions for this extended time period are considered unacceptable.

- Draining Diamond Lake would be accomplished by constructing an engineered system designed to drain the lake via pumping and siphoning. The system would be designed to discharge approximately 250 cfs and would be comprised of a platform, in the lake, to hold pipe, which would automatically lower as the level of the lake drops. Diesel pumps would fill the pipe until the pipeline began to function as a siphon, the pumps would then be shut off. Water discharged from the lake would be transported via a overland 48 inch pipeline directly to Lemolo Lake and then into the North Umpqua river. The pipeline would follow the Lake Creek drainage, away from and above the channel until it reached Highway 138 where it would follow close to the existing road to Lemolo Lake. The in-lake inlet structure would be fitted with screens that would inhibit tui chubs from entering the discharge pipe. Road construction would be required for construction and access along the 14.5 miles of pipeline. Road construction would occur within the Mt. Bailey Roadless Area. The estimated cost for implementing this alternative is $26.6 million.
    - This alternative was eliminated because: it is violates existing roadless area policy; it is technologically infeasible because the pipe is vulnerable to fire, vandalism, and earthquakes; environmental impacts to Lake Creek and its associated Riparian Reserves and fauna are unacceptably high; and complex and potentially extended negotiations with PacifiCorp would be required.

- Draining Diamond Lake would be accomplished as described in the previous alternative except, water would be piped into the closest PacifiCorp canal (Clearwater I at Stump Lake) instead of Lemolo Lake. After piping water from Diamond Lake to the Lake Creek/Highway 138 crossing, the most feasible route to the Clearwater I canal would be to follow Highway 138; it is approximately 6 miles from the Lake Creek highway crossing to the Clearwater I Canal (it is 4 miles from this point to Lemolo Lake).
    - This alternative was eliminated because it shares all of the draw backs documented for the above alternative and it would require 2 additional miles of pipeline. Pipeline along Highway 138 would be particularly

susceptible to vandalism. Although less stream and riparian miles would be impacted than described above, ecological impacts are still considered unacceptable because it would impact the 6 stream miles from Diamond Lake to Lake Creek.

U. An alternative was considered that would utilize active siphoning to lower the lake level by 10-30 feet to reduce the cost of a chemical treatment. This alternative was eliminated from detailed study because: (1) preliminary cost estimates for construction and implementation of a siphoning system exceeded 2 million dollars and thus financial benefits are speculative; (2) environmental impacts of maintaining Lake Creek at bankfull for substantially longer time periods than needed to accomplish an 8' draw down are considered unacceptable; and (3) a full range of draw down options are represented by a complete drain of the lake (explored above) and the 8' draw down in Alternative 2. An infinite number of draw down levels are available for consideration, but do not further address the significant issues.

V. An alternative was considered that would utilize explosives to eradicate tui chub from Diamond Lake. This alternative was eliminated from detailed study because explosive experts consider it to be logistically infeasible and speculative (Pers. comm., Jerry Firth, Gary McElroy, Jerry Harman). To be successful, a lake-wide simultaneous explosion would be required; there are no known examples of the utilization of explosives for a lake-wide treatment of this scale. Detonation cord is the primary explosive that has been used in fishery management to kill unwanted fish. Treatment of Diamond Lake with detonation cord would require placement and simultaneous firing of approximately 574 miles of detonation cord to create the desired magnitude of explosion. Experts would not recommend detonation cord for a Diamond Lake treatment; however, any type of explosives would require connections (shock tubes) between individual charges to achieve a simultaneous blast, thus all explosive options are considered infeasible.

W. An alternative was considered that would utilize Antimycin, (Fintrol®) another fish toxicant, rather than rotenone to eradicate tui chub in Diamond Lake. From 10/5/03 to 10/10/03 aquatic researchers from the Pacific Northwest Research Station in Wenatchee, Washington conducted bioassays on tui chub using Antimycin in a laboratory setting at Diamond Lake. Based on information and questions generated from the available literature, the specific variables the researchers were requested to test included: 1) the effectiveness of Antimycin on tui chub in the presence of macrophytes; 2) the effectiveness of Antimycin on tui chub using different concentrations of the chemical; 3) the effectiveness of Antimycin on tui chub at varying pH levels. The preliminary results of these bioassays are incorporated by reference into this document and relevant conclusions are documented below:

- Briefly stated, at the manufacturer's recommended concentration for use in fisheries management (5 ppb), Antimycin was ineffective at killing tui chub at the pH's and temperatures found in Diamond Lake in the fall.
- Researchers replicated tests at Antimycin concentrations of 10 ppb and 15 ppb and although the chemical was more effective at the higher concentrations, it still took longer than expected to achieve a 100% fish kill (approximately 17 hours).

- Due to the difficulty encountered trying to kill chub at 5 ppb, researchers did not test the effectiveness of Antimycin in the presence of macrophytes. However, literature indicates that Antimycin tends to adhere to macrophytes and localized pH increases that may occur near macrophyte beds could result in additional reductions in Antimycin effectiveness in these areas.

Several additional factors related to utilization of Antimycin were researched and considered by the IDT: 1) at concentrations needed to kill tui chub, it was considered likely that non-target species (aquatic invertebrates and amphibians) would also be killed; 2) Brian Finlayson, an expert in the utilization of fish piscicides in fisheries management, concluded that Antimycin would not be an effective tool for eradicating tui chub in Diamond Lake (Pers. comm.); 3) the rapid degradation process of Antimycin reduces the probability of achieving mixing into deeper parts of the lake prior to the chemical losing its effectiveness; 4) if Antimycin were utilized, a concentration of 10 ppb to 15 ppb would be required, estimated costs for purchase of adequate amounts of the chemical at these concentrations would be $4,224,000 and $6,336,000 respectively. Following consideration of all of the above, this alternative was eliminated from detailed study because it was considered technologically infeasible, economically unreasonable, and the probability of success at meeting the purpose and need utilizing this chemical was speculative.

X. Subsequent to the development of Alternative 4, an alternative was considered that would add an annual lake draw down to the proposed mechanical harvest of tui chub. The objective of this modification would be to increase the effectiveness of the alternative at limiting tui chub populations. This alternative was eliminated from detailed study because maintaining Lake Creek at bankfull conditions for extended periods of time over multiple years would result in unreasonable environmental harm. Additionally, due to the depth and extent of aquatic macrophytes for spawning, annual draw downs would not be expected to achieve the goal of increased success at limiting the tui chub population.

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